DECEMBER 1961

the JOURNAL of ENVIRONMENTAL SCIENCES

OFFICIAL PUBLICATION OF THE INSTITUTE OF ENVIRONMENTAL SCIENCES

RADIATION EFFECTS ON MANNED SPACE FLIGHTS

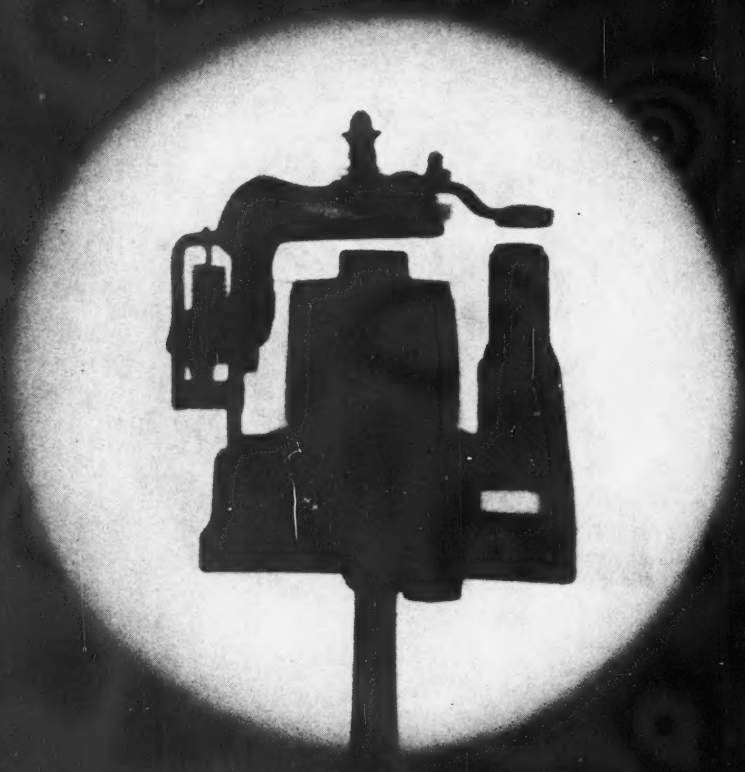
TENSILE CRYOSTATS

STATIC LOAD TESTING USING AIR PRESSURE IN PLASTIC BAGS

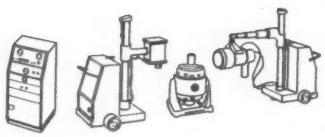
SHOCK AND VIBRATION OF STANDARD MILITARY VEHICLES

MR. DONALD W. DOUGLAS JR.
See page 16B

The important advances in environmental testing come from MB



New MB-Zenith 150 KV pulsed X-ray system takes motion pictures of high speed phenomena



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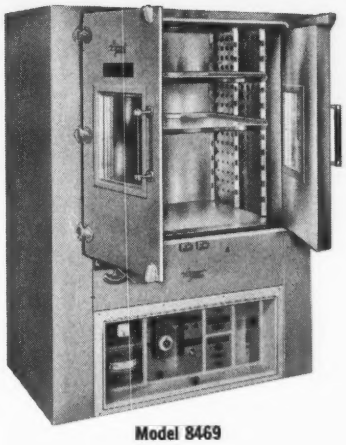

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*Mil-E-005272B (USAF) Procedure I, Paragraph 4.1.1, Procedure II, Paragraph 4.2.2 and MIL-P-116D, Paragraph 4.4.6.

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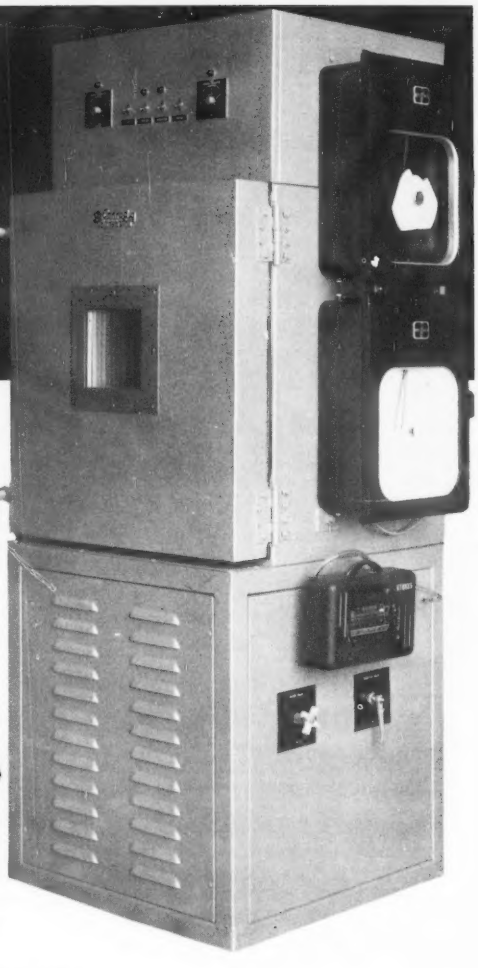

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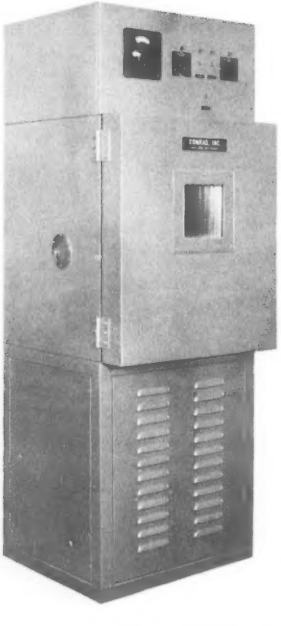

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VOLUME 4 NUMBER 6

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the JOURNAL of ENVIRONMENTAL SCIENCES

For active Environmental Engineers and the executives throughout industry who are concerned with the advancement of Environmental Engineering by the Institute of Environmental Sciences.

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John D. Campbell TECHNICAL EDITOR
Ray W. Kopriva ART DIRECTOR

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Mr. William Holden of the Philco Corporation has served as Assistant Technical Editor for the December 1961 issue of the *Journal of Environmental Sciences.*

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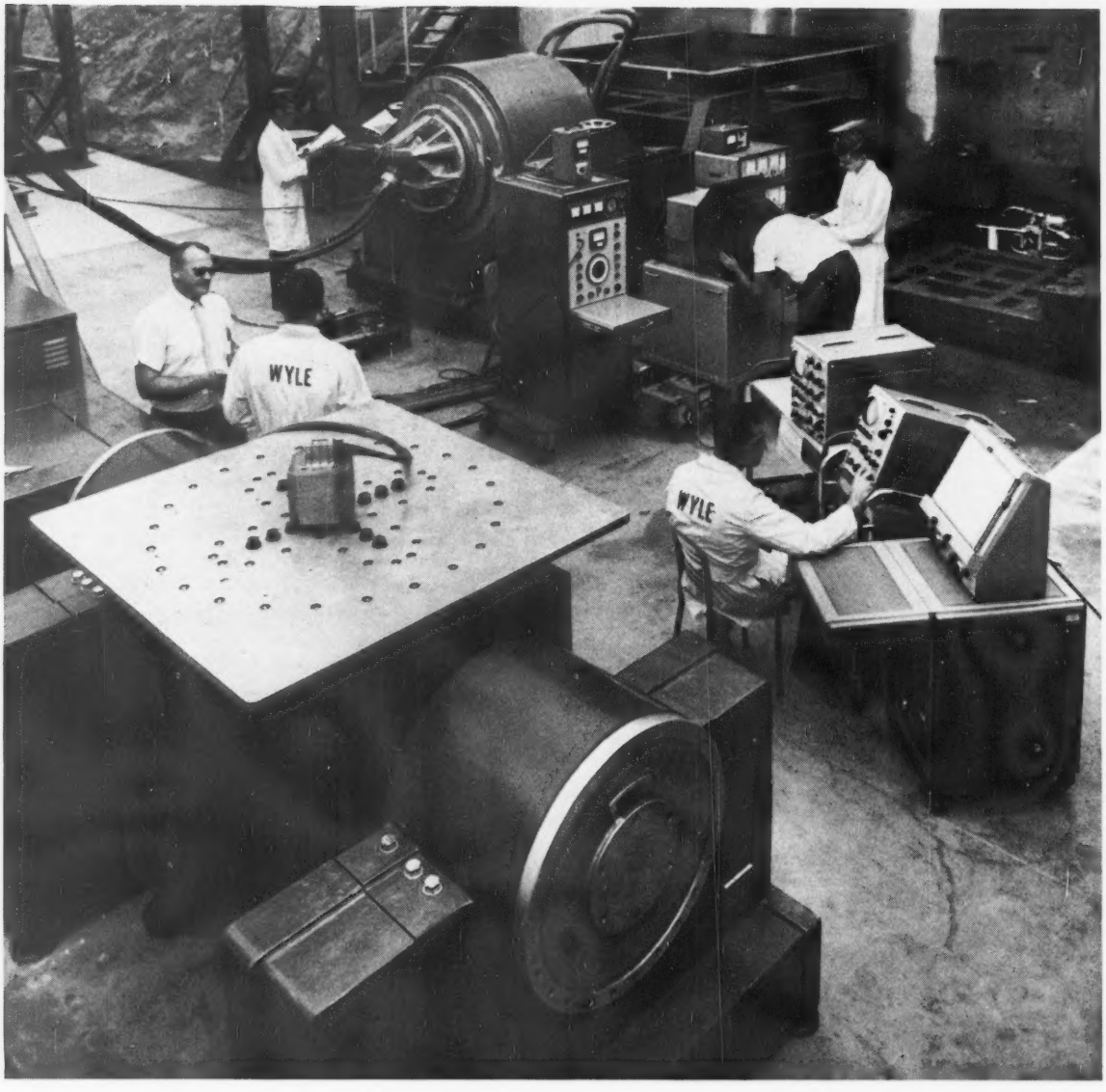

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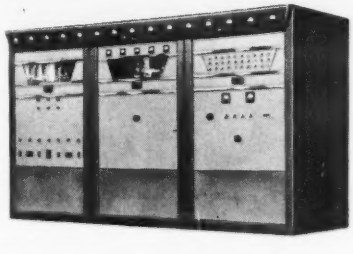

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EXECUTIVE COMMITTEE HIGHLIGHTS

The Institute of Environmental Sciences Executive Committee met in Detroit on October 9, 1961. This meeting had the best attendance of any in the past.

The Executive Committee elected Jerome Bakalish, John Boyle, and John Sexton to the membership classification of Fellow. They also approved the application for charter from three new local chapters. Details on page 28.

Mr. Don Fox reported on the progress of the 1962 Technical Meeting and Equipment Exposition. All appears to be well and we can expect to hear many original and high level technical papers.

Mr. Sander reported on his review of West Coast convention facilities. The committee voted to hold the 1963 Meeting in Los Angeles, Calif. on April 17, 18, and 19, 1963 at the Statler Hilton Hotel.

A discussion was held on the 1964 Meeting site. The East Coast was approved as the general location. A specific facility will be chosen in April 1962.

Mr. Amorosi's report on the Standard's Committee was read. The committee has held several meetings and is working with the American Standards Association.

Mr. Vandal reported the Education Committee has just about completed a compilation of all past chapter University programs. This will be made available to chapters planning to start their own programs.

Mr. Askin reported on the Handbook Committee. It is the Committee's opinion that the Handbooks issued by other groups serve a limited group and will soon be out of date. They have been asked to compile an outline of their objectives.

A new committee has been formed. The Specification Review Committee, chaired by Mr. Harold Jones of the University of Maryland, will review Military Specifications and comment on the environmental aspects.

Mr. Billet read a letter from the President of the American Vacuum Society that expressed the possibility of an affiliation. Mr. Billet, Mr. Fox, and Mr. Sander are to look into the matter.

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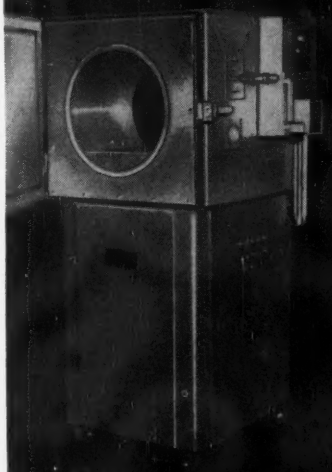

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COMMITTEE RE

ROGER J. AMOROSI
CHAIRMAN

The ASA Sectional Committee on Glossary of Environmental Terminology met on October 19, 1961. This committee is chaired by Mr. Roger Amorosi of Electrical Testing Laboratories. Mr. Amorosi is the National Chairman of the Institute of Environmental Sciences Standards Committee, the sponsoring group for the ASA Sectional Committee.

Mr. William Allen of N.A.S.A. was appointed to chair a subcommittee that will prepare a list of related qualified glossaries and dictionaries on environmental terminology. Any one having knowledge of such glossaries or dictionaries can aid the subcommittee by informing Mr. Allen at Headquarters, N.A.S.A., Washington 25, D. C.

The committee prepared a List of Environmental Factors to use as a basis for discussion. These factors were regrouped into the following tentative categories. Atmospheric, Biological, Chemical, Earth, Electrical, Mechanical, Nuclear, and Space. Each committee member will prepare comments on the category allied to his field.

The next meeting for the group is planned for February, 1962 in New York City. Institute of Environmental Sciences members who have any suggestions or comments for the committee should contact Mr. Roger Amorosi c/o Electrical Testing Laboratories, 2 East End Ave., New York 21, N. Y.

AL *STANDARDS*

EE *REPORT*

DISCUSSION GROUPS

ENVIRONMENTAL FACTORS

TEMPERATURE
(THERMAL STRESS)
HUMIDITY
RAIN
SLEET AND SNOW
MARINE
FUNGUS
SAND AND DUST
SALT FOG
SUNSHINE
OZONE
CORROSION
CONTAMINANTS
WIND
SHOCK
VIBRATION
ACCELERATION
DECELERATION
RADIATION
SOLAR
ELECTROMAGNETIC
NUCLEAR
ELECTRICAL PARTICLES
ZERO G
METEOROIDS
ALTITUDE
HIGH VACUUM
THERMAL VACUUM
EROSION
EXPLOSION
ACOUSTICS
NOISE

PROCESSES

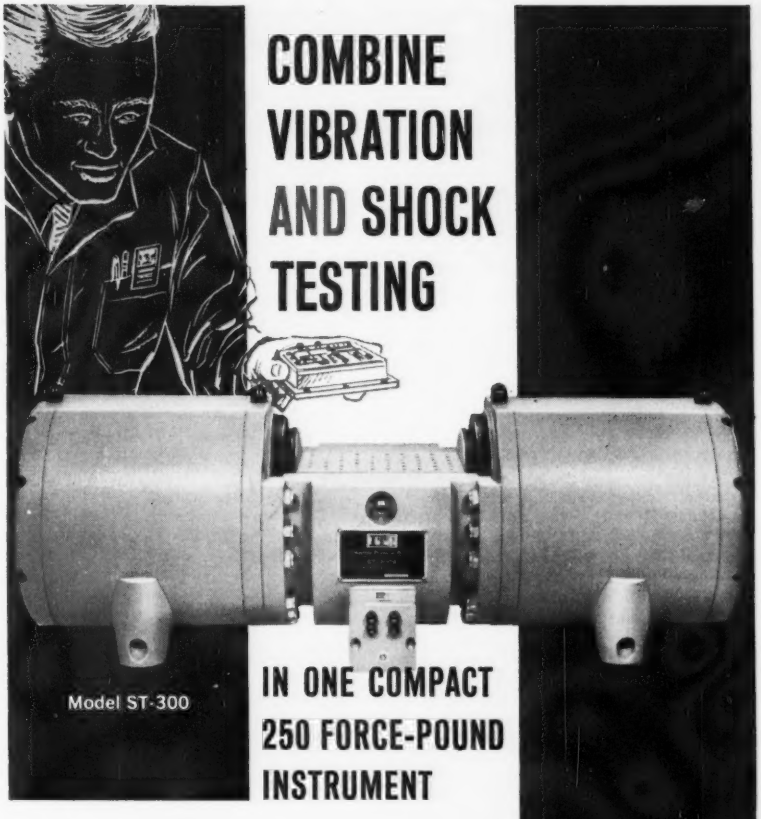
EARTH ENVIRONMENTS
ATMOSPHERIC ENVIRONMENTS
SPACE ENVIRONMENTS
PHYSICAL ENVIRONMENTS

HUMAN FACTORS

PHYSIOLOGICAL
PSYCHOLOGICAL
BIO-ASTRONAUTICS

FIELDS

GEOLOGY
GEOMORPHOLOGY
GEOGRAPHY
CLIMATOLOGY
TERRAIN
METEOROLOGY
PEDOLOGY
HYDROLOGY



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RADIATION EFFECTS ON MANNED SPACE FLIGHTS

By HERBERT S. APPLEMAN

Air Weather Service (MATS)
United States Air Force

INTRODUCTION

The effects of radiation at and near the surface of the earth have been studied for many years and are fairly well known. In general, because of the screening properties of the earth's environment, these effects are negligible. But with the advent of manned flight into the very high atmosphere and space, the problem must be re-examined. Unfortunately, because of the scarcity of measurements at these altitudes, the data necessary for a definitive analysis of the effects of radiation are not now available, and will not be available for several years. In the interim, newly acquired information will be disseminated to keep Air Weather Service personnel current on the state of knowledge in this field.

The potential radiation hazards that must be considered are the ordinary galactic cosmic rays, radiation from a quiescent sun, radiation from an active sun (solar flares), and the Van Allen radiation belts that surround the earth. Fortunately, it has been found that radiation from the first two sources is of negligible importance as a space-flight hazard. This report, therefore, will deal mainly with problems arising from solar flares and the radiation belts.

RADIATION PROTECTION GUIDE

Everyone is constantly exposed to the effects of radiation — from sunlight, radioactive materials in the earth, medical X-rays, etc. However, as long as the rate and total amount of radiation received are kept below specified values, the radiation is considered permissible. (Because of the aforementioned variables, however, the term "permissible" should be regarded only as a guide.) Table I indicates certain actual and permissible dosages.

The actual safe radiation limits are as yet unknown. They vary with the individual, the rate at which the dosage is received, the energy level of the radiation, etc. As indicated above, a one-time exposure of 25 r and a lifetime total of 200 r are considered permissible[4,12]. Actually, in an extensive test on a group of Rhesus monkeys, no effects of any kind were detected with exposures below 200 r; another group of animals received a total of 4100 r over a two year period without fatalities[4].

SUNSPOTS

Sunspots are important to the radiation hazard problems because of their relationship to solar flares. Sunspots are not clearly understood, but are believed to be storms caused by solar gases flowing into low-pressure areas, similar to terrestrial cyclones. The expansion of the gases in the low results in cooling and, hence, in a darkening of the area. The dark central core is called the umbra; it is surrounded by filaments of a somewhat lighter region, called the penumbra (see Figure 1).

Some days before a sunspot begins to form, a series of bright patches (faculae) appear on the surface of the sun. Suddenly, often in just a few hours, a hole forms in the facular area and the sunspot is born. The faculae continue to exist throughout the lifetime of the sunspot and for some days or weeks thereafter.

Sunspots occasionally occur singly; usually, however, they are found in pairs or in complex groups elongated in the direction of solar rotation. A pair consists of a preceding and a following spot, although it is believed that one of the pair may sometimes be submerged below the solar surface and not visible except through its influence on the faculae in the region. The two spots have opposite magnetic polarity. If the preceding spots in the sun's northern hemisphere have positive polarity, the preceding spots in the southern hemisphere will be negative. The polarities of the spots appear to reverse with each 11-year cycle, indicating that the true sunspot cycle may actually be a double one lasting a total of 22 years.

The smallest known sunspots are called pores, and are a few hundred miles in diameter. The largest spots measure 20,000 miles or more across the penumbra. A large double group may extend 100,000 miles across, and more complex groups may be even larger. Any spot larger than 25,000 miles in diameter can be seen by the naked eye.

Small sunspots are short-lived, lasting but a day or so. Larger ones, with fully developed penumbrae, may persist for several weeks. Only a few sunspot groups last long enough for solar rotation to bring them around two or more times. An example is shown in Figure 2. The longevity record for a sunspot group, 18 months, occurred in 1840-41.

Sunspots normally occur in either solar hemisphere at latitudes less than 35 or 40°. They rotate with the sun, whose period of revolution varies from 25-1/3 days at the equator to 27-1/2 days at 40°. A gradual and fairly regular rise and fall occur in the number of sunspots, with a mean period between successive maxima of 11.2 years. This period is quite variable, however, and has ranged in the past from 7.5 to 16 years. At the beginning of the cycle, most spots lie between 20 and 30° latitude. As the cycle progresses, the spot zones tend to form closer to the solar equator.

The most recent sunspot cycle reached its maximum value in March 1958, with a monthly mean sunspot number of about 205. (The sunspot number is a function of the number of individual spots and groups.) The anticipated value of the next minimum (probably near June 1964) is from three to ten. In addition to the 11-year sunspot cycle, there appears to be a long-range period of about 100 years in sunspot numbers. For a long time now there has been a tendency for each sunspot maximum to be greater than the previous one (Figure 3). The next peak (around 1968-69) is expected to be the last of the increasing sequence or, more probably, the first of the decreasing sequence. During the following 50 years or so it is expected that the activity will be reduced each cycle, possibly falling to a sunspot maximum below 50 (as compared to the March 1958 value of 205) before the activity again starts to increase.

SOLAR FLARES

Solar flares occur only in those regions of the sun where sunspots exist. The flare shows up as a sudden brightening of the facular area surrounding the sunspot. The flare reaches peak brightness within a few minutes, then decays over a period of 30 minutes to several hours. Flares are generally divided into four classes according to size: 1, 2, 3, and 3+. Class 1 flares, which are the smallest, have a mean duration of 15 minutes and occur every few hours during periods of maximum sunspot activity. Class 3+ flares, on the other hand, have a mean duration of three hours and occur on an average of but once or twice a year. Occasionally, class 3+ flares have

ACTUAL DOSAGES WITH NO SHIELDING (r = roentgens)

(Including both particulate and electromagnetic radiation)

Dosage rate at sea level	0.4 r/yr
Dosage rate in undisturbed space (for galactic cosmic rays)	.5 to 12 r/yr
Dosage rate in space during solar flares	10 to 1000 r/hr
Total dosage in space during a solar flare	2 to 400 r
Dosage rate in heart of inner Van Allen belt	24 r/hr
Dosage rate in heart of outer Van Allen belt	200 r/hr

A GUIDE TO MAXIMUM PERMISSIBLE DOSAGES

Lifetime total dosage	200 r
One-time dosage	25 r
For professional radiation workers	3 r/13 wks or 5 to 12 r/yr*

*Actual value depends on prior exposure. A radiation worker is allowed 12 r/yr until he has accumulated 5 r for each year of his age past 18; then 5 r/yr thereafter [Federal Radiation Council Report No. 1]. If the same policy is followed in space flights, a new astronaut, age 18, would be permitted but 5 r/yr, while another new astronaut, age 32, with no significant prior exposure to radiation, would be allowed 12 r/yr until the age of 42, then 5 r/yr thereafter. However, consideration is being given to permitting astronauts to receive exposures somewhat higher than those allowed ordinary radiation workers.

TABLE 1

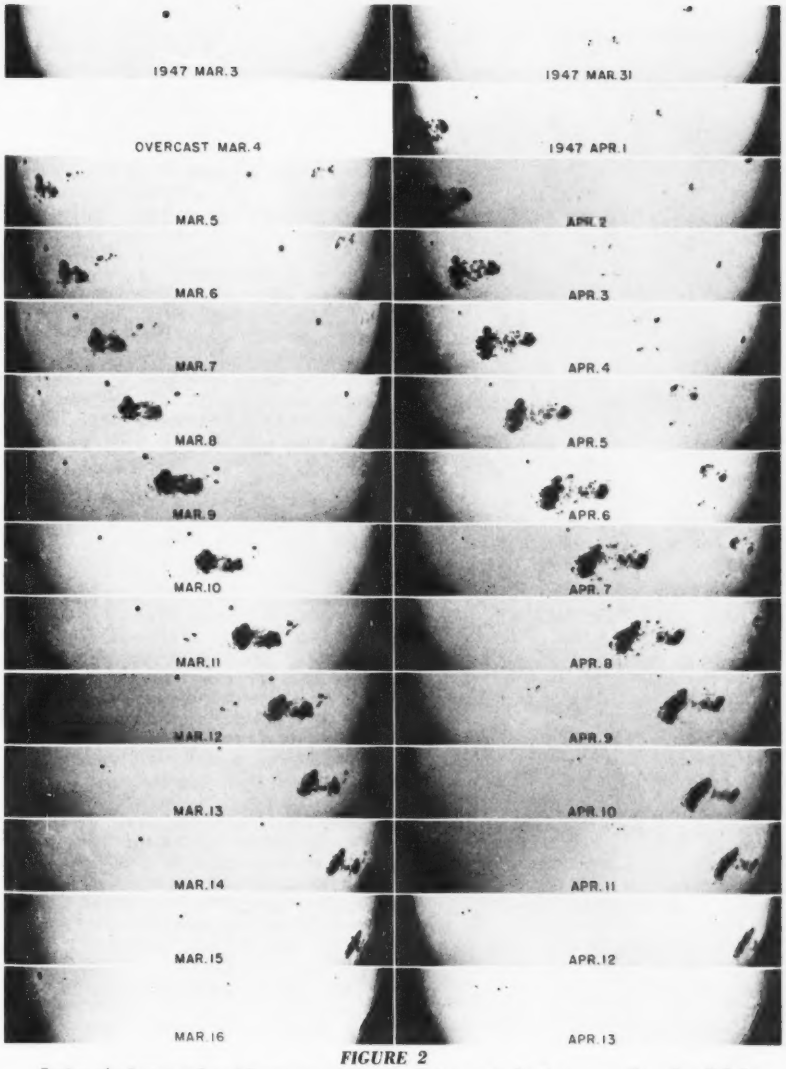

FIGURE 2

Series of photographs of large sunspot group being carried twice across the solar disk by the sun's rotation, 3 March through 13 April 1947.

lasted longer than five hours.

Flares may produce a number of effects in the vicinity of the earth. These include radio fadeouts, called Sudden Ionospheric Disturbances or SID's, which occur on the sunlit side of the earth almost simultaneously with the onset of the flare. They result from an abrupt increase in the ionization of the ionospheric D-layer due to ultraviolet radiation from the sun. The fadeout generally lasts for a period of a few minutes to several hours. Not all flares produced SID's, however.

About a tenth of the largest flares (greater than class 2) are followed in about one or two hours by a sharp rise in cosmic ray activity on both the light and dark sides of the earth. Primary cosmic rays (as they reach the earth's outer atmosphere), consist of about 85% protons (hydrogen nuclei), 14% alpha particles (helium nuclei), and 1% heavier nuclei (i.e., nuclei of heavier elements). Of these, the protons appear to be by far the most important, since the alpha particles have little penetrating power and the heavy nuclei are so few in number. The usual cosmic-ray flare produces protons with energy levels up to several hundred Mev (million electron volts). The much rarer high-energy flares result in significant proton emission at energy levels ranging from 1 to 20 Bev (billion electron volts), or even higher. Since the earth's magnetic field deflects most of the incoming cosmic rays away from the equator, the protons mainly bombard the polar regions. The proton radiation intensity reaches a maximum value fairly quickly, then falls off in accordance with the time-square law ($I_t = I_{max}/t^2$), although the bombardment may last from 10 to 100 hours.

Geomagnetic storms, ionospheric disturbances, and aurorae begin with the arrival at the earth of a stream of charged particles (of uncertain identity, but generally assumed to be electrons and protons) between 10 and 30 hours after a flare. They occur simultaneously on the light and dark sides of the earth, and may seriously disrupt certain types of radio and land-line communications for several days. What appears to be a relatively minor solar disturbance may be followed by a great geomagnetic storm, while an apparently larger solar event may produce only minor effects at the earth. This is not true with proton bombardments, however. As mentioned in the preceding paragraph, only the larger flares result in significant proton discharges.

All proton-producing flares are associated with sunspot areas, generally with the more complex regions accompanied by frequent minor flare activity. A perfectly clear solar disk will not produce a flare, and any sunspot-produced flare on the back side of the sun will not affect a vehicle on the near side. Any sunspot region that has already produced one flare is likely to produce more. Thus, the passage of such a region across the face of the sun (as the sun rotates) may give rise to a number of such events at intervals of a few days. Obviously, space flights should be limited, or preferably not made, during such periods.

A flare-producing sunspot region may last for

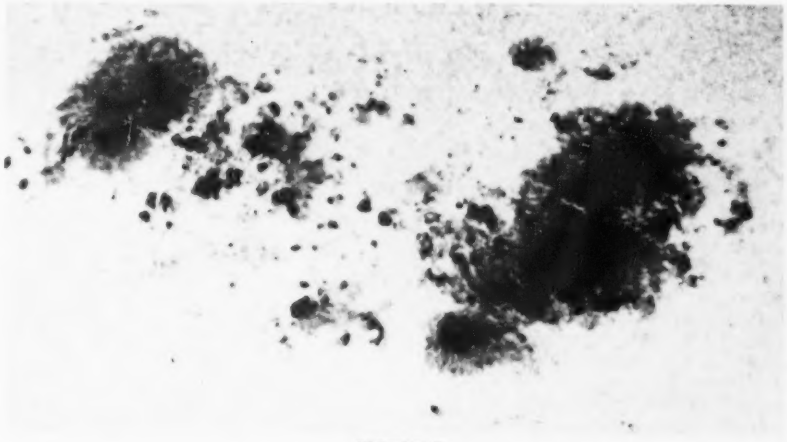

FIGURE 1

Large sunspot group showing several umbrae and associated penumbrae, 7 April 1947. This is an enlargement of a portion of Figure 2. "Photographs from the Mount Wilson and Palomar Observatories".

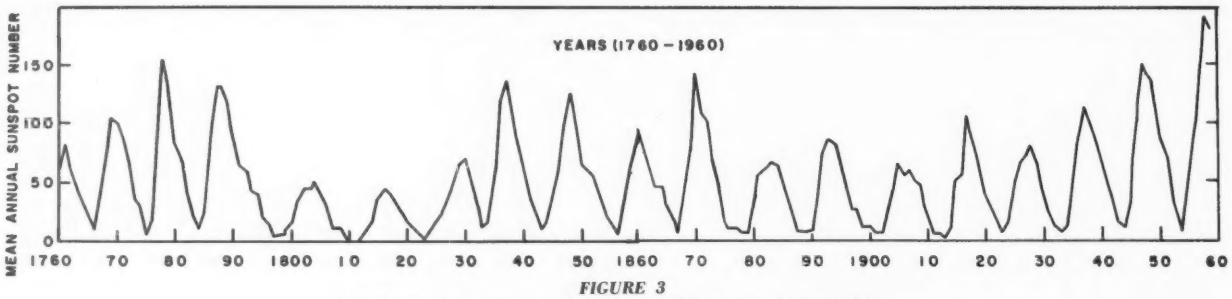

FIGURE 3

Variation in the mean annual sunspot numbers over the past 200 years.

weeks or even months. Since the sun rotates approximately once each 27 days, such a region may disappear behind the sun, then reappear. However, this reappearance can be forecast quite accurately. The most unpredictable flares are those produced by sunspot regions that form on the back side of the sun and rotate around to the front side (a sunspot region can form in just a few days). However, it is possible that a warning might be given through detection of radio-frequency energy refracted from the back-side sunspots. Also, small fluxes of solar protons might reach the earth in conjunction with a back-side flare near the edge of the solar disk.

If no complex sunspot area or any area that has already given rise to a flare exists on the front side of the sun or is expected to reappear from the back side, the chances of getting a 7-day period free of solar flares are good. (A 7-day clear period would be desired for a trip to the moon and back.) In years of minimum sunspot activity, such safe periods are common. For example, only one small cosmic-ray flare occurred during the last solar minimum in the 4-year period 1952-1955. An astronaut would have been exposed to very little danger from flares during this period. On the other hand, during the last solar maximum there was no day in which there were not several large regions potentially capable of producing flares. A total of 25 cosmic-ray flares actually occurred during the 2-year period 1957-1958. Thus on any one day there was slightly over a 3% chance of exposure to a proton flare, during an arbitrary 4-day period about a 12% chance, and during a 7-day mission about a 19% chance.

With 8 gm/cm^2 of shielding, a man would receive a total dose of from 2 to 170 r for the whole flare event. Such shielding large enough to protect a man and his food for a day or two would weigh under 1000 pounds. (In space the solar cosmic rays appear to be isotropic, so shielding would be needed on all sides.) Assuming a permissible dosage of 25 r (the suggested guidance value) and 8 gm/cm^2 of shielding, about a third of the proton flares detected at the earth would have produced excessive dosages inside a vehicle in space. Thus the chances of exposure to above-permissible radiation during periods of solar maximum would be about 1% on any one day, or 4% over an arbitrary 4-day period. With some prediction capability, the latter figure could be reduced to not more than 1%. The chances of receiving a lethal dose (usually estimated as in the neighborhood of 400 r) would, of course, be very much less. During periods of solar minimum, there would be a still further reduction in the danger of solar flare radiation.

Only about five or six of the very high-energy solar cosmic-ray emissions have occurred since 1942. Although originating in active regions on the sun, these high-energy flares do not appear to be related to peaks in the sunspot cycle. One hazard of the high-energy particles is that the first 100 gm/cm^2 of shielding actually increases the total radiation dose, due to the formation of secondary particles from the shielding material. Although it apparently is not feasible to shield against these flares, their rarity (only one 4-day flight in several hundred would probably be hit) reduces the hazard.

Since protons are charged particles, the magnetic field of the earth acts to deflect most of the radiation toward the polar regions. As long as flights are carried out below the lowest part of the Van Allen belts (i.e., below about 600 km) and between ±50° geomagnetic latitude, any radiation dose would be small. The early man-in-space flights, such as Project Mercury, are planned for these safe

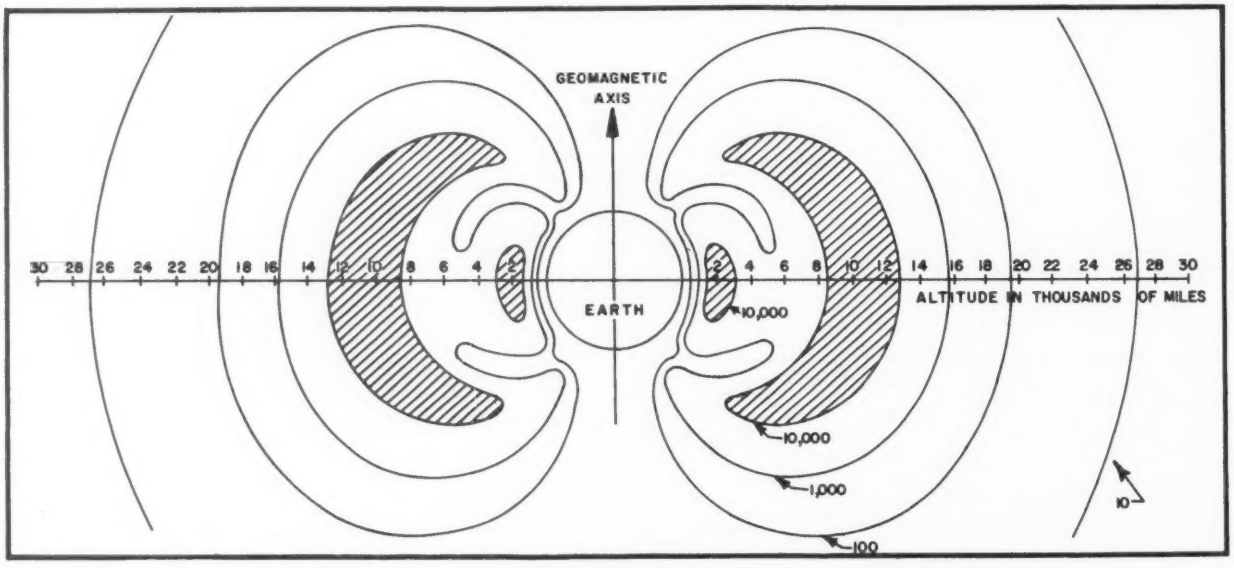

FIGURE 4

Van Allen radiation belt intensity profile. Intensity values are in Geiger-tube counts per second.

areas. Later space flights, however, will undoubtedly cross the unprotected polar regions, and eventually flights will be made above the Van Allen belts where the earth's magnetic field would be too weak at all latitudes to deflect the proton beams.

Some attention has recently been given to the forecasting of proton flares, notably by Anderson of the University of California and by Evans of the Sacramento Peak Observatory. These techniques take into account the presence of sunspots, the size and complexity of the sunspot area, the size of the associated penumbra, and the past and current activity of potential flare regions. Although these techniques are still undergoing development and testing, there appears little doubt but that significant success will be achieved before the arrival of the next solar maximum.

RADIATION BELTS

At the fringes of the earth's atmosphere and extending out into space lie the Van Allen radiation belts. Figure 4 is based on a diagram by Van Allen which shows a cross section through the belts in the plane passing through the magnetic poles, with the radiation values given in terms of Geiger-tube counts per second. Note that neither belt extends over the magnetic poles. The inner ring, centered about 2000 miles above the magnetic equator, consists of hard (i.e., penetrating) radiation. It is believed to be made up of high-energy protons and lower-energy electrons; these result from primary galactic cosmic rays striking the earth's atmosphere and forming neutrons which, in turn, decay into secondary protons and electrons. The outer ring, centered near 10,000 miles, consists of soft radiation, probably composed of relatively low-energy electrons and protons from the sun; because of their lower energy, shielding against them would be fairly simple. These two radiation belts are caused by the charged particles becoming trapped in the earth's magnetic field. Some of the particles from the outer ring strike the earth's atmosphere in a circular pattern around the magnetic poles, exciting atmospheric gases so that they reradiate. This reradiation is called the aurora.

The dipole field of the earth is off-set from the center of the earth by about 225 miles. Thus, the lower edge of the inner radiation belt is less than 300 miles over Santiago, Chile, and more than 990 miles over Australia (both at the same latitude). Measurable radiation belt intensities are found above 600 miles in equatorial regions, and above 200 miles in high latitudes. Over the equator, the maximum intensity of the inner belt occurs near 2000 miles, and of the outer belt near 10,000 miles. The outer zone extends to 35,000 miles; beyond this point the earth's magnetic field is too weak to trap the charged particles.

The inner zone is relatively stable, but the outer zone fluctuates with solar activity. At the onset of a magnetic storm, the intensity of the outer belt falls rapidly to a very low value ("dumping effect") and auroral displays appear. Then a rapid increase in intensity occurs, sometimes greater than the pre-storm level, followed by a gradual decline to the pre-storm level.

Manned space flights designed to orbit the earth would ordinarily operate below the radiation belts. However, flights to the moon, and possibly later to the planets, would generally require the astronauts to penetrate these regions, although it might be possible to take off over the polar regions not covered by the belts. In continous flight through the lower belt, unless very heavy shielding was available, a person would receive a dosage rate of several r/hr. Actually it has been estimated that a trip out and back through the inner belt in a reasonably shielded vehicle would result in a total dose of not more than 3 to 4 r. In the outer Van Allen belt, because of the lesser energy of the radiation, proper shielding would reduce the dosage rate to 0.1 r/day, a negligible value.

Above the Van Allen belts, over the polar regions, the dosage rate would be only about 0.01 to 0.03 r/day in the absence of flares. Assuming a total permissible radiation dose of 25 r, it is seen that a round trip to the moon (estimated at about seven days) in a reasonably shielded vehicle could safely penetrate the two radiation belts and tolerate an average-size solar flare in addition. Even if an entire orbit were made in the lower radiation belt through a misfire, this limit would not be exceeded signficantly, if at all. However, very high-energy flares of intensities greater than several hundred million electron volts would almost certainly result in total dosages greater than the permissible value, and in rare cases would be lethal.

About the Author

Mr. Appleman graduated from the University of Illinois in 1940 with a BS degree in electrical engineering. During World War II he attended the University of Chicago as an Air Force cadet in meteorology. After receiving his comission he remained as an instructor for the following class, then served the remainder of the war as a weather officer in the Pacific. At the end of the war he returned to the University of Chicago, receiving the MS degree in meteorology in 1947. He then joined the U. S. Weather Bureau as a research meteorologist on the Thunderstorm Project. In 1949 he joined the newly created Directorate of Scientific Services of Air Weather Service, becoming chief of the Atmospheric and Space Physics Branch in 1958. Mr. Appleman is presently on a year's absence from this position, having returned to the University of Chicago for additional study in the field of physical meteorology and astrophysics.

REFERENCES

NOTE: This report is a general survey of the problem of radiation effects on space flights. The various bits of information presented do not in the most part represent independent contributions, but rather a synthesis of the ideas of a number of investigators who have drawn from and added to a common storehouse of knowledge. Consequently, rather than attempting to give separate credit for each statement, those references that provided most of the background for the paper have been listed alphabetically.

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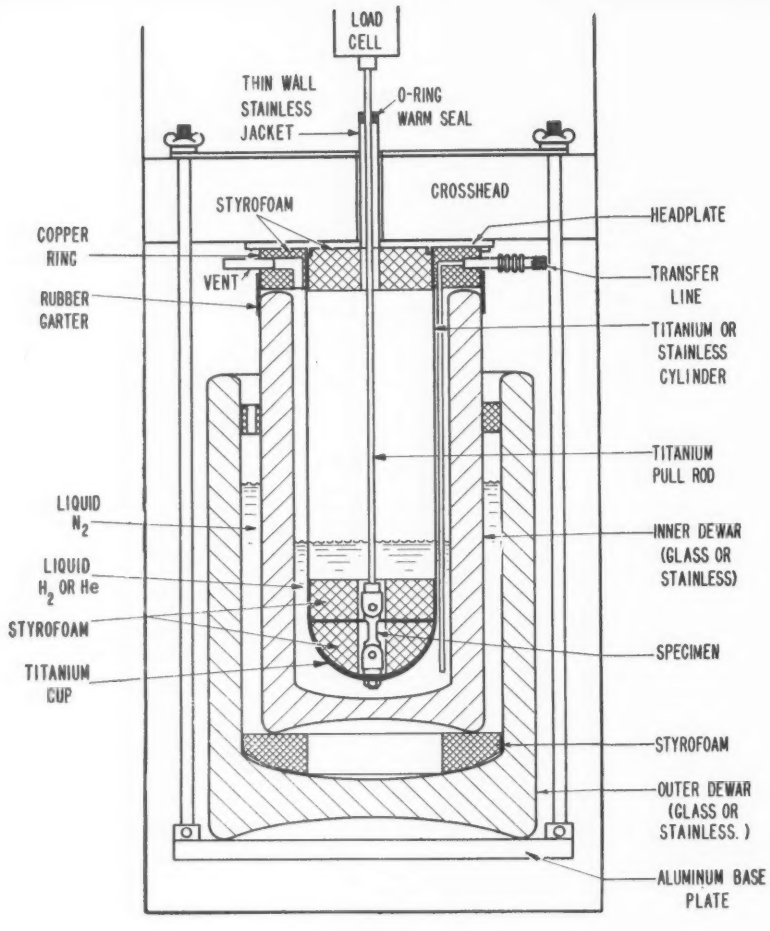

FIGURE 1

Schematic drawing of the tensile cryostat having a load capacity of 10,000 pounds. Stress is applied to the specimen by moving the crosshead downwards, the force being transmitted through the cylinder-cup arrangement.

Two tensile cryostats have been developed by the National Bureau of Standards Boulder (Colo.) Laboratories for making tensile tests at temperatures as low as 4.2°K. In one of these devices the tension apparatus passes through a metal Dewar; in the other it extends into—but not through—the Dewar.

Two tensile cryostats, capable of making tests at temperatures as low as 4.2 °K, have been developed by the Cryogenic Engineering Laboratory of the National Bureau of Standards Boulder Laboratories. The first of these devices, designed by R. M. McClintock and K. A. Warren, is capable of sustaining tensile forces up to 5000 pounds.[1] The second, designed by R. P. Reed, has a load capacity in excess of 10,000 pounds.[2] The two cryostats differ not only in capacity, but in construction and operation as well. Both offer the advantages of simplicity, safety, and low consumption of liquefied gas.

The rapid growth of cryogenic engineering has increased the need for information concerning the properties of materials at low temperature. This is true not only of the fluids normally used to achieve low temperatures, but of the many materials which may be used in low temperature installations. Of special interest is the effect of extreme cold on metals—a factor to be considered in the design of facilities for producing, transporting, and storing liquefied gases.

5000 POUND DEVICE

The cryostat having a capacity of 5000 pounds is used with standard tensile equipment. The tension linkage extends completely through a stainless steel Dewar and the specimen is submerged in liquid cryogen during low temperature runs. The major modification of the equipment is the extension of the tension linkage through the vacuum space between the walls at the bottom of the Dewar. Force is transmitted across the vacuum space through a stack of metal washers, this arrangement having been found to result in less heat flow than a solid rod of the same dimensions. To further reduce heat flow into the bottom of the cryostat, the region where the linkage passes through the bottom of the outer shell of the cryostat can be surrounded with liquid nitrogen. A stainless steel bellows is welded to the bottom of the inner shell to permit specimen alignment with the universal-type linkage joint enclosed within the vacuum space and to allow for thermal contraction.

The top of the flask is closed during runs by a rigid foamed polystyrene cover which extends about 6 in. into the cryostat and which surrounds the outer walls to the same depth. A gas-tight seal is formed between the lower end of the cover and a ring soldered around the outside of the cryostat by means of a thin rubber sleeve. A tube for filling and emptying the cryostat runs down through the cover. The transfer line extends down through this tube during filling and is removed and the hole corked during runs to reduce heat flow. A fluid-level float, various electrical leads, and the upper tension rod also pass through gas-tight seals in the cover. There is a depression in the cover which may be filled with liquid nitrogen to further reduce heat flow into the cryostat during helium runs.

When determinations are to be made at the temperature of a particular liquid, the cryostat is filled with the

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1 For further details, see Tensile cryostat for the temperature range 4 to 300 K, by R. M. McClintock and K. A. Warren, Materials Research & Stand., 1, 95, Feb. 1961).

2 A cryostat for tensile tests in the temperature range 300 to 4 °K, by R. P. Reed, talk presented at the 1961 Cryogenic Engineering Conference, Ann Arbor, Michigan.

CRYOSTATS DEVELOPED BY N.B.S.

liquid so as to cover the specimen. The cryostat is precooled with liquid nitrogen prior to a helium run. When tests are to be made at temperatures intermediate to the boiling points of various liquids, an open-bottom plastic gas chamber is attached to the upper tension rod so as to surround the specimen; when the cryostat is filled with liquid, the sample remains in a gaseous atmosphere. Heat is then supplied to the specimen by small electric heaters on the upper and lower specimen holders, and the desired temperature, as measured by thermocouples attached to the specimen, is maintained by automatic or manual control of the autotransformers used to supply current to the heaters.

The liquid consumption of this cryostat is, when using hydrogen, about 2½ liters, which will cover the sample for 2½ hours. Three liters of liquid helium are required to cover the sample for 20 minutes when the nitrogen reservoirs are filled. Insulation is provided by the evacuated space between the walls of the cryostat, in preference to multiple layer insulation that would take at least 24 hours to reach thermal equilibrium. A charcoal getter is incorporated within the vacuum space to maintain the desired vacuum for several months without repumping.

10,000 POUND DEVICE

In the second cryostat the tension apparatus extends into—but not through—the Dewar. This feature allows glass Dewars to be used, as no strain is put upon the container itself. The tensile load is applied in such a manner as to eliminate the need for low temperature seals—in fact, only one room temperature 0-ring seal is needed.

Specimens to be tested are suspended within the Dewar from a titanium pull rod, the upper end of which is attached to a load cell. The lower end of the specimen is attached to a holder which passes through, and is bolted to, a hemispherical cup. The top of the cup is attached to a cylinder, which in turn is attached to a headplate. The headplate is pressed downward to apply a load to the specimen, the force being transmitted through the cylinder and cup to the sample.

The cylinder-cup arrangement is surrounded by a metal Dewar containing liquid hydrogen or a glass Dewar containing liquid helium. A second Dewar of liquid nitrogen is placed around the inner flask when helium is used, or during long runs with hydrogen. Styrofoam blocks, loosely surrounding the specimen, are used during helium runs to conserve liquid by taking up space. The inner Dewar is supported on styrofoam spacers in the bottom of the outer Dewar; the latter being held securely in place by a lower plate or by pin fittings. The inner flask is sealed from the atmosphere by a rubber sleeve which is clamped to it and to a copper ring just above the top of the Dewar. When glass Dewars are used, slits in the silvered surfaces permit visual determination of the liquid level; with metal Dewars, a carbon probe is used.

The liquid consumption of this cryostat is also quite low. Three to seven liters of helium will provide a test period of 2 hours, and 2 to 5 liters of hydrogen can be used for tests lasting 4 hours. Runs at room temperature, and at intermediate temperatures using boiling liquids or various slurries, can be performed quickly and easily.

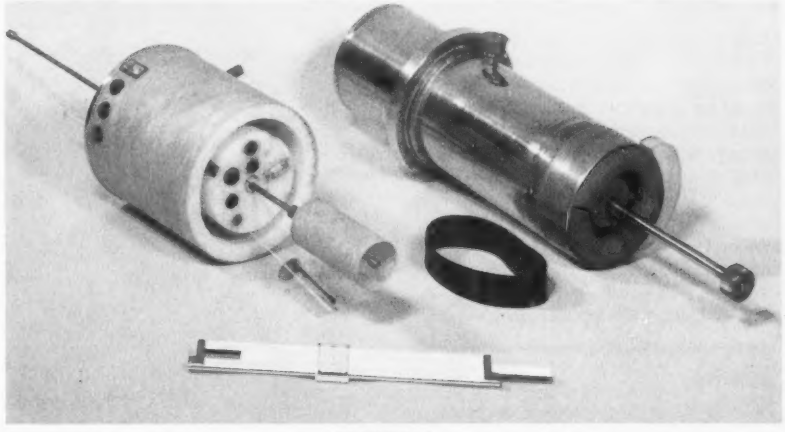


FIGURE 2

Photograph of the tensile cryostat in which the tension linkage extends through a metal Dewar. At left is shown the foamed polystyrene cover, with the upper tension linkage (center of cover) and liquid-level float running through it. The metal Dewar is at right, showing lower tension linkage, liquid nitrogen reservoir, and vacuum fitting. The rubber sleeve is used to make the junction between top and bottom gastight.

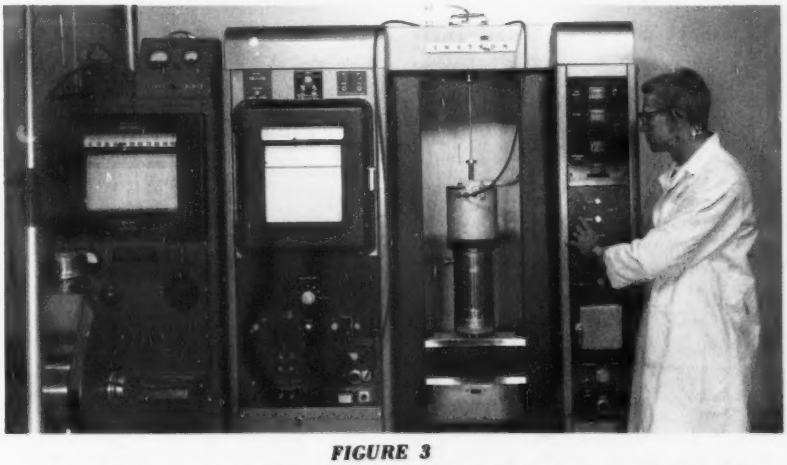


FIGURE 3

K. A. Warren of the National Bureau of Standards Cryogenic Engineering Laboratory performs a tension test with the tensile cryostat having a load limit of 5000 pounds.

STATIC LOAD TESTING USING AIR PRESSURE IN PLASTIC BAGS

By GEORGE M. GIFFORD
I-T-E Circuit Breaker Co.

EDITORIAL COMMENT

Since the author does not include detailed information on the measurement methods or the actual test results the degree of accuracy can only be surmised. Since the test loads are applied normal to the surface, whereas wind loads (over most of the dish area) are not, the wind loading simulation appears to be at best an approximation. The technique is a very interesting innovation, however, and should give satisfactory results where approximate deflection estimates are adequate.

Summary

There are many methods of load testing antenna reflectors. These methods, with the exception of wind tunnel tests, and the following method, employ dead weights or point loads equivalent to the amount of load the antenna reflector is to withstand. In this article a method is described using inflatable plastic bags.

The principle purpose in statically loading antenna reflectors is assuring the permanence of reflector surface contours under high wind and icing conditions. Since the development of high power radar transmitters and sensitive receivers, the size and surfaces of antenna reflectors have become increasingly important. As a result of this, static load tests on reflectors up to 60 feet by 30 feet and larger, have become desirable.

To test a reflector of this size using the dead weight method would require approximately 22,500 pounds of dead weight for a 75 mph wind. Aside from the unwieldiness of this amount of weight, any failure would be catastrophic. The wind tunnel is not practical since the antenna is so large it would be difficult to put it in the wind tunnel and it is difficult to measure accurately the deflections under the load conditions. Using the bags, accurate repeatable deflection measurements can be taken. Care must be exercised, however, not to mistake rotational motion for deflection.

Discussion

A simple and accurate method would seem to be inflatable plastic bags pressing against the reflector. A 75 mph wind on an expanded metal concave surface is only 12.5 lbs. per sq. ft. of air pressure, which is easily contained. A 200 mph wind on a solid conclave surface at $-60°F$ is only 1.23 psi of air pressure. A failure of the antenna will only transfer the weight of the antenna from the fixture or support to the bag. If the antenna has a delicate mesh surface, it will not be damaged by uniform pressures. The pressure is easily obtained and held using a blower and valves, and since it is low, it can be released quickly.

This method of load testing may also be used in conjunction with a scale model wind tunnel test. Wind tunnel data may indicate that a wind from a slight angle produces a greater load on the support structure. By changing the pressure distribution in the bags, non-uniform wind loads may be simulated. Of course, the bag pressure on the surface of the reflector is normal to the surface, however, non-uniform loads generally are more damaging to the antenna mounts. As a result, the unequal application of the load results in the desired torsional stress to prove the strength of the mount during rotational loading.

During a test, the pressures may be accurately controlled and depending on the measurements, two people can easily perform the test.

The photographs show a test on a 60 foot x 30 foot praboloid reflector. Another unit of the same reflector is in the background on the pattern test fixture. The second photograph illustrates the reflector support mounted on the concrete foundation. The third photograph shows a small 9 foot x 17 foot reflector under test. In both tests scales were attached to the reflectors and supports and read with transits during the tests, although dial indicators could have been set up on the smaller units. The results in both cases were accurate within a thirty-second of an inch and were with care, repeatable. Deflection measurements are made with respect to ground. We assumed the point of attachment to the pedestal to be rigid as it's deflection is on the order of 0.01 or less, however, this point is also checked with reference to ground. The information obtained from the test as described is the deflection of the antenna, flatten-

About the Author

Mr. George Mason Gifford has been with I-T-E Circuit Breaker Company, Special Products Division for the past five years. He has been in charge of the Mechanical Test Department and the Environmental Test Laboratory. He has also done technical writing and currently is working in Mechanical Testing. He attended Haverford College and evening courses at Drexel Institute of Technology. Prior to his association with I-T-E, he spent two years at White Sands Missile Range operating a ground telemetry station for the U. S. Army.

Mr. Gifford is a member of the Institute of Environmental Sciences.

INSTITUTE OF ENVIRONMENTAL SCIENCES

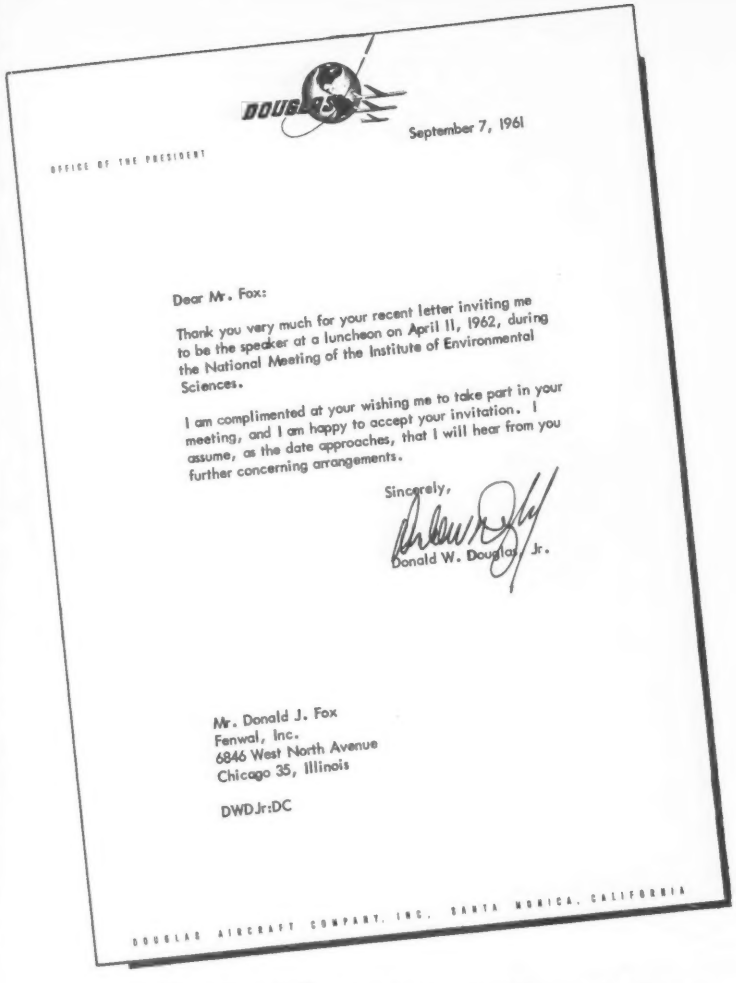
1962

TECHNICAL MEETING AND EQUIPMENT EXPOSITION

APRIL 11, 12, and 13, 1962

SHERATON CHICAGO HOTEL **CHICAGO, ILLINOIS**

Will You Be There?



DOUGLAS

September 7, 1961

OFFICE OF THE PRESIDENT

Dear Mr. Fox:

Thank you very much for your recent letter inviting me to be the speaker at a luncheon on April 11, 1962, during the National Meeting of the Institute of Environmental Sciences.

I am complimented at your wishing me to take part in your meeting, and I am happy to accept your invitation. I assume, as the date approaches, that I will hear from you further concerning arrangements.

Sincerely,

Donald W. Douglas, Jr.

Mr. Donald J. Fox
Fenwal, Inc.
6846 West North Avenue
Chicago 35, Illinois

DWDJr:DC

DOUGLAS AIRCRAFT COMPANY, INC. SANTA MONICA, CALIFORNIA

Mr. Donald W. Douglas Jr., President of the Douglas Aircraft Company will be the Luncheon Speaker for the Wednesday Luncheon. Among the topics he will discuss will be the recent advances in the Aircraft Industry.

TECHNICAL PROGRAM

Twenty four sessions . . . Seventy Two Original Technical Presentations. Session Groups are: Human Factors, Environmental Equipment, Environmental Techniques, Environmental Design and Analysis, Shock and Vibration, Thermal Environments, Theoretical, Special Problems, Nuclear Radiation, Materials Degradation, Space Facilities, Field and Laboratory, Space Simulation and Acoustics. The Technical Meeting will be conducted with four simultaneous sessions each morning and afternoon for the full three days. The Proceedings of the meeting will be distributed at the meeting.

MICHIGAN BOULEVARD

GATEWAY TO THE 19
MEETING AND EQUIPM

Ladies Prog

A very active Ladies program has
with a "Get Acquainted" Tea la
Wednesday and Thursday will be
ities, such as, tours of a Flower S
Shore Suburbs, Michigan Aven
Place, Museum of Science and In
University of Chicago, Chinatow
also scheduled, one Swedish styl
the other will be a family style

ULEVARD CHICAGO, ILLINOIS

THE 1962 TECHNICAL EQUIPMENT EXPOSITION

adies Program

s program has been planned starting
ainted" Tea late Tuesday afternoon.
ursday will be devoted to many activ-
of a Flower Show, Navy Pier, North
ichigan Avenue Shops, McCormick
cience and Industry, Lake Meadows,
go, Chinatown. Two luncheons are
Swedish style with a puppet opera,
family style Chinese luncheon.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

IN REPLY REFER TO

OFFICE OF THE ADMINISTRATOR
1520 H STREET NORTHWEST
WASHINGTON 25, D. C.
TELEPHONE: EXECUTIVE 3-5000 TWX: WA 788

November 7, 1961

Mr. Donald J. Fox
Executive Vice President
Institute of Environmental Sciences
6846 West North Avenue
Chicago 35, Illinois

Dear Mr. Fox:

Thank you for your letter of October 4 and the invitation to be the guest speaker at the luncheon on April 12 during the annual National Meeting of the Institute of Environmental Sciences. I am pleased to accept your invitation.

Sincerely yours,

James E. Webb

James E. Webb
Administrator

Mr. James E. Webb, Administrator for the National Aeronautics and Space Administration will address the Thursday Luncheon group. His subject will be announced in the February issue of the Journal of Environmental Sciences.

EXHIBITS

Eighty three booths are planned for this year. At the time of this printing 50% of the booth space has been reserved. Exhibitors are: Associated Testing Labs, American Research Corp., B & K Instruments Inc., Barry Controls, The Bethlehem Corp., Blue M Electric Co., Cardox, Chadwick-Helmuth Co., Conrad Inc., Consolidated Vacuum Corp., Endevco Corp., I.T.T. Industrial Products Div., Liquid Carbonic Div., Ling Electronics Div., M B Electronics, Minneapolis Honeywell Inc., Missimers Inc., Murphy and Miller Co., National Research Corp., Research Inc., Royco Instruments, F. . Stokes Corp., The Strong Electric Corp., and Tenney Engineering Inc.,

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The special attention that the Treasury is giving to deductions for travel and entertainment puts taxpayers on the spot to prove that the cost of convention attendance is an "ordinary and necessary" business expense. Deductions have been disallowed because the taxpayer had no records to prove that the time devoted to meetings was sufficient to justify the cost of the trip.

The best supporting document you could find to bolster your deduction is your copy of the program. It gives a day-to-day, hour-by-hour account of what transpired, who spoke, what they talked about, and the opportunities for discussion and participation. To round this out, every member should take some notes at every session (to show he was there) and also clip and keep news items and articles published before and after the event.

Another effective safeguard is to write a report to top management or the board of directors immediately after returning. It should summarize the proceedings and pass along ideas and suggestions picked up at the convention. Even without a tax motive, this is a good habit to get into, for obvious reasons.

JOHN P. ANTOLAK

In the October issue of the Journal of Environmental Sciences we announced the Committees for the 1962 Meeting. Mr. Neal Granick was listed as the Chairman of the Publicity Committee. Since then Mr. Granick has found it necessary to resign as Chairman. Mr. Donald Fox, the General Chairman, has appointed Mr. John P. Antolak of Liquid Carbonic Div., of General Dynamics as the new Publicity Chairman. Mr. Antolak will continue the program prepared by Mr. Granick.

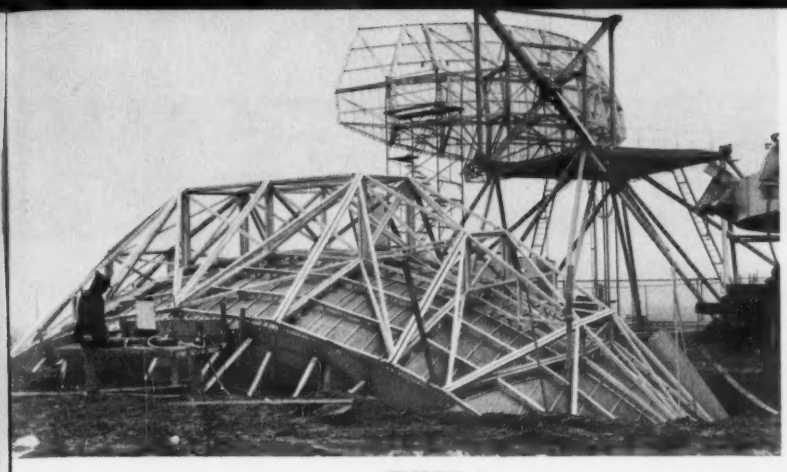


FIGURE 1

A 60 foot x 20 foot paraboloid reflector. A vertical position of the same unit is shown in the background.

FIGURE 2

Reflector support mounted on a concrete foundation.

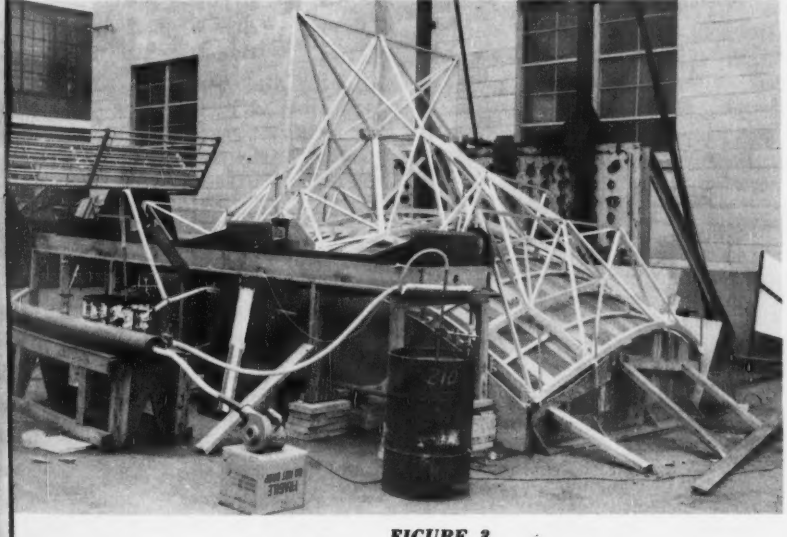


FIGURE 3

A small 9 foot x 17 foot reflector under test.

ing of the contour and motion of the support structure.

Test Method

To set-up a test on a paraboloid 60 foot x 30 foot reflector, for example, is the most difficult stage of a test. A foundation must be installed and since a reflector may be very deep, it is sometimes more practical to shape the earth beneath it to simplify the use of the bag. A wall must be put around the reflector to hold the bags under it. Because of the curvature of the reflector, the pressures required are different across the surface. In this case, five separate bags were used and the pressures compensated to the mean requirement for each surface. The five bags had to be separated by walls to keep them in their proper location since the pressures were not equal in each bag.

Once the bags are in place they are easily inflated using a hand blower. The control equipment required is a manifold to distribute the air and manometers to monitor the pressures.

The actual test takes very little time, a cycle from zero pressure to dead weight of the antenna, 30 mph wind, 75 mph wind and back to zero may be accomplished in 20 minutes dependent on the blower capacity. If deflection measurements are desired, the time for the measurements are the limiting factor of the test.

The 60 foot by 30 foot antenna tested was loaded 3 times in one morning and deflections were measured at 12 locations. Each time the readings were within 1/16 of an inch. During one cycle the pressure on one side was higher than the other. This caused a rotation of the mount. Measurements of the mount motion confirmed this and correction factors were easily applied. The antenna was then removed from the load test fixture and placed on the pattern test range. The mesh surface had taken a slight permanent set, however, the radiation characteristics were unaffected, further emphasizing the gentleness of this test method. Even under the maximum load, deflections were within the manufacturing tolerances for the surface contour.

Conclusion

The inflatable bag, despite a long set-up time, has the advantages of quick, easy loading of the article to be treated. It is safe for both the testing personnel and the reflector under test. There is no risk of the shock load of a dropped

Continued on page 24

LETTERS TO THE EDITOR

SUBJECT: Vibration X-Ray Techniques

Dear Editor,

In the last issue of the Journal you included an article titled "Vibration Testing and the Perpetuation of the Mystery". I am sure most members of the Institute of Environmental Sciences feel as I do that this article did not depict a very realistic picture of the present state of vibration testing. True, there is room for improvement in the area of vibration testing. However, there are people searching in the darker areas for solutions to today's problems. If the statement "It is precisely here, where testing should provide the knowledge for redesign, that the present methods of vibration testing have failed to be of utility" were true, a tremendous amount of effort continues to be wasted each day throughout the nation performing useless vibration tests.

The "most usual testing situation" as described in the article appears to be the usual acceptance or qualification test and not the usual development test. In the field of development testing there are many competent engineers who are aware of the many methods used for "reading the output" when they are performing vibration tests to obtain data usable for redesign.

How about keeping the records straight? Let us have some articles from the readers of the Journal on how they have eliminated some of the mystery of vibration testing.

Very truly yours,
L. V. Omelka

Dear Editor,

Mr. Jack Fromkin's article, "Vibration Testing and the Perpetuation of Mystery" published in the October, 1961 *Journal of Environmental Sciences* described the need for a technique to observe the internal dynamics of encased components while undergoing vibration testing. Mr. Fromkin concluded his article by stating that X-ray techniques had the most promise to achieve his objectives. He went on to say that the limitation in applying X-ray techniques was the state of the X-ray art.

Zenith Radio Research Corporation recognized the need for improved X-ray equipment, as pointed out by Mr. Fromkin, a little over three years ago. A development program, which was recently completed, resulted in the construction of X-ray motion picture equipment which can shed considerable light on Mr. Fromkin's mystery.

The objectives of the X-ray equipment development program were as follows:

1) be capable of making X-ray motion pictures of specimens which are moving at high velocity
2) penetrate specimens equivalent in thickness to at least 3" of aluminum
3) synchronize the pictures with the motion of the specimen

When it is desired to take a blur-free X-ray picture of an object traveling at high speed, it is necessary to limit the radiation from the object that exposes the recording film to a short time interval. In order to limit the blur to 10% of the total displacement, the film exposure should occur during less than 5% of the cycle, i.e., in the case of a specimen being vibrated at 1,000 cycles per second an exposure time less than 50 microseconds.

One method is to continuously illuminate the object and use a fast shutter which limits the exposure. The second is to pulse the illuminating source so that its "on" time is short enough to stop motion.

The former method using continuous X-ray illumination of the subject has been in use for a number of years. The equipment typically consists of an X-ray source (designed to X-ray motionless objects), a fluorescent screen (which converts X-ray energy to light energy) and a motion picture camera which is focused on the fluorescent screen. Since short exposure time is required to stop motion most of X-radiation is wasted, thus severely limiting the penetration ability. Therefore, the latter method, i.e., pulsing the illuminating source to achieve stop motion was chosen. By using this technique it is possible to increase the X-ray radiation intensity by a factor of 10,000 or more during the "on" time, thereby increasing the penetration considerably, and also eliminating the need for a fast camera shutter.

The completed system consists of the following: a pulsed X-ray source, image intensifier tube, closed circuit TV, pulse camera, and slip-sync.

The X-ray tube is pulsed up to 30 times per second with a 20 megawatt one microsecond square wave. The X-ray tube current at 150 Kv. beam voltage is 130 amperes. Previous X-ray generating equipment produced only a few milliamperes beam current at 150 Kv., so it is readily apparent that the penetrating capability during a short time period has been greatly increased.

The image intensifier converts the X-ray image to a visible light output which is simultaneously viewed on closed circuit TV and recorded on motion picture film by the pulse camera.

A little should be said about the rate of taking pictures. Going back to our example of a specimen being vibrated at 1,000 cycles; if we were to take a picture every cycle of the specimens motion we would limit the operation of the equipment to a very short running time or to much lower radiation energy per pulse. Fortunately, it is not necessary to pulse every cycle. The Slip-Sync equipment makes it possible to synchronize the X-ray pulse with a sub-multiple of the vibration frequency, resulting in good quality motion pictures at a pulse rate of approximately 24 pulses per second. The Slip-Sync equipment causes an apparent slow-motion presentation of the specimen by automatically changing the phase slightly between the X-ray pulse repetition rate and the vibration table frequency.

Thus, I feel the work done at Zenith Radio Research Corporation has fulfilled Mr. Fromkin's requirements by making it possible to X-ray monitor specimens continuously during vibration testing.

Yours truly,
George A. Ohlmann
Zenith Radio Research Corporation

SHOCK AND VIBRATION OF STANDARD MILITARY VEHICLES

By ROBERT KENNEDY
U. S. Army Transportation Research Command

Introduction

Transportation of cargo and the consequent shock and vibration effects on the cargo present a field in which the approach must be refined and specific when the handling of sensitive materials is considered. Most previous work in this field resulted either from a requirement to solve a problem concerning damage that is of a specific type or from a need to include all possible types of cargo in order to show the versatility of a particular product to be sold.

The relationship between safety and shock and vibration in the transporting of sensitive materials is such that the results would be disastrous if the shock and vibration were exaggerated or if the effects of the shock and vibration were minimized. If the degree of shock and vibration input were estimated below the actual amount of g's and if serious damage to the cargo resulted, the negative results would be quite obvious. On the other hand, if the degree of shock and vibration were overestimated, the mobility of the items would be seriously impeded and again an unsafe condition would exist.

It is imperative that the shock and vibration input to the cargo by various modes of transport under all conditions be accurately determined. Our objective is to insure not only that a sensitive cargo has a safe trip but that it has as broad a range of transportability as possible. With most commercial shipments, a trial and error procedure of checking damage claims against various shipping routes and modes of travel is sufficient to determine safeguards for the future against damage caused by shock and vibration. Obviously, this method cannot be used in determinations for our present weapons.

The over-all program is a continuing study covering shock and vibration effects on cargoes transported by many types of vehicles and by all modes of transportation. The problem of transporting sensitive materials occurs in five general areas of transportation; namely, highway, rail, air, amphibious and sea. This paper is limited to a discussion of a small portion of the highway phase only. A standard military truck was selected as the first vehicle to be studied since this vehicle is one of the most commonly used transportation media.

The test of a standard military vehicle is also designed to determine the shock and vibration effects caused by different road conditions and by vehicle suspension components, particularly the tires. It is the intent of this paper to show the basic approach to the evaluation and to indicate the results that have been analyzed to date.

Evaluation

An M-52 truck tractor operating in combination with an M-127 semi-trailer was selected for initial shock and vibration studies. This combination is a general-purpose vehicle. The truck tractor is classed as an M-52, 5-ton, 6x6, 167-inch wheel-base tractor; the semi-trailer is classed as an M-127, 12-ton, 4-wheel, dual-axle trailer with a cross-country payload of 24,000 pounds and a smooth-highway payload of 36,000 pounds. The combination was tested over a range of roadways, the test-run courses consisting of a typical highway, a secondary road, a low-type road, a paved road with a rail crossing, and a corduroy-type road, any or all of which could be encountered during cross-country road movements. (See Figure 1.)

All tests have been completed, but, to date, only the results of the tests on the corduroy-type road have been analyzed. Data on the other type road conditions are currently being compiled and analyzed. Figure 2 shows the corduroy road over which the shock and

FIGURE 1

Truck tractor and semi-trailer used to conduct tests.

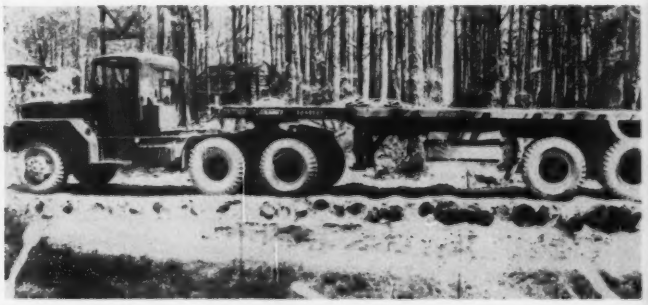
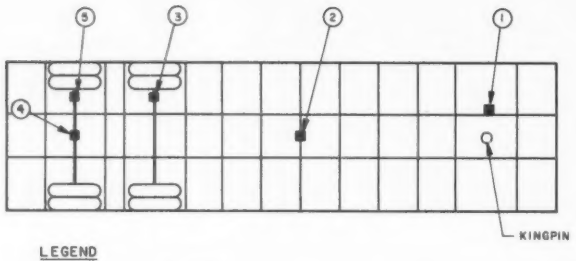


FIGURE 2

Test Vehicle on a portion of the corduroy road bed.



LEGEND

① CENTER FIFTH WHEEL
② GEOMETRIC CENTER
③ LEFT FRONT AXLE
④ CENTER OVER REAR AXLE
⑤ LEFT SIDE OVER REAR AXLE

FIGURE 3

Instrumentation sketch M127 Semi-trailer.

vibration tests were conducted. The road consists of logs 12-24 inches in diamter, placed crosswise on a firm sand base. The course is approximately 14 feet wide and 400 feet long. This type road generates perhaps the most severe low-frequency vibration to the vehicle and the load. It is certainly the most severe of all the test conditions in the program.

The principle instrumentation was comprised of 5 accelerometer transducers, all mounted in a vertical direction and located on the trailer as shown in Figure 3. All accelerometers were of the Statham unbonded strain-gage type and had a natural frequency of 350 cps and a flat range of up to 200 cps. Data from the transducers were recorded on a Consolidated Engineering Corporation 18-channel recorder in conjunction with a direct-current Balancing Bridge. The galvanometers limited the frequency response with a natural frequency of 100 cps and a flat range of up to 60 cps.

Four accelerometers were located on the main suspension members of the bed and one was located on the axle, as shown in Figure 3. The accelerometer on the axle was used to aid in the comparison of the tires and also to correlate the shock imparted to the road. Accelerometers were placed at various locations on the truck bed to pick up any differences attributed to location.

The recording instruments and power supply were housed in a separate ¾-ton truck. This proved to be a cumbersome arrangement and presented a problem; the test vehicle and the vehicle carrying the recording instruments had to operate approximately parallel to each other during a test run in order to maintain electrical contact between the power and the transducers. Telemetering equipment is now available and will be used

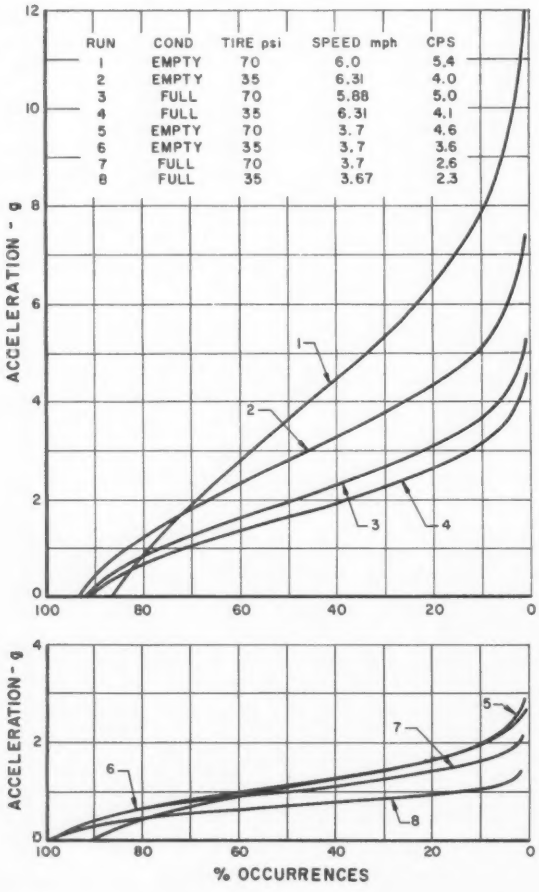

RUN COND TIRE psi SPEED mph CPS
1 EMPTY 70 6.0 5.4
2 EMPTY 35 6.31 4.0
3 FULL 70 5.88 5.0
4 FULL 35 6.31 4.1
5 EMPTY 70 3.7 4.6
6 EMPTY 35 3.7 3.6
7 FULL 70 3.7 2.6
8 FULL 35 3.67 2.3
ACCELERATION - g
% OCCURRENCES

FIGURE 4

Vehicle Accelerations for Standard Tires over Corduroy Road.

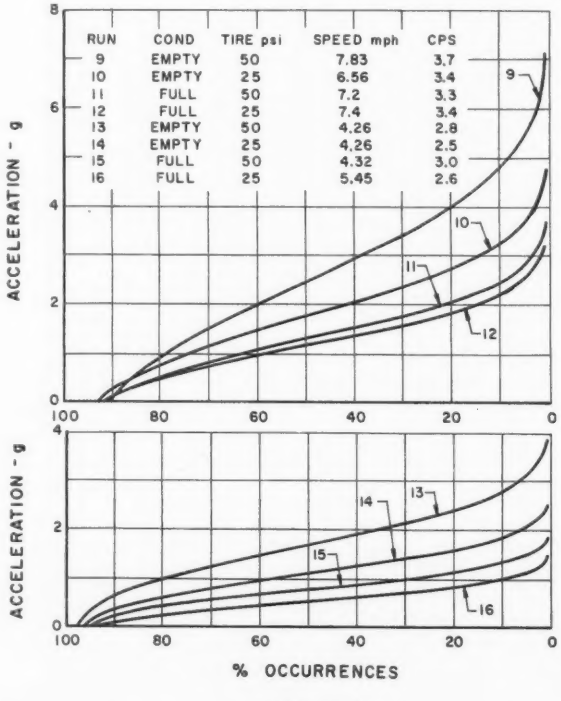

RUN COND TIRE psi SPEED mph CPS
9 EMPTY 50 7.83 3.7
10 EMPTY 25 6.56 3.4
11 FULL 50 7.2 3.3
12 FULL 25 7.4 3.4
13 EMPTY 50 4.26 2.8
14 EMPTY 25 4.26 2.5
15 FULL 50 4.32 3.0
16 FULL 25 5.45 2.6
ACCELERATION - g
% OCCURRENCES

FIGURE 5

Vehicle Accelerations for Desert Tires over Corduroy Road.

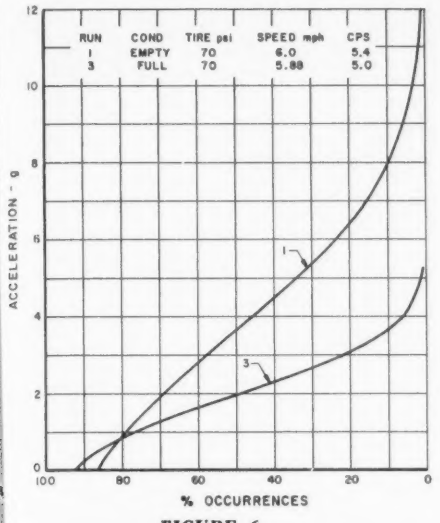


FIGURE 6

Comparison of Full 24,000 lb. Load and Empty Load.

in future vehicle tests.

Tests on the corduroy road were run with the following vehicle variables; standard military tire (11:00 x 20); military sand tire (14:75 x 20); recommended tire pressure and one-half recommended tire pressure; speeds of 4 and 6 miles per hour; load condition, empty, and load condition, 24,000 pounds.

The peak accelerations were measured for a specific frequency over a given time interval of the trace. These accelerations were then recorded on IBM tape for use with an IBM 1620 computer. The 1620 computer was then used to compute various statistical expressions as the mean and standard deviation. The net result is that the computer program produced a smooth curve fitted and determined by good statistical practice. Actually, the original data produced good curves and probably were sufficient for our purposes. A check of a few runs shows that the statistical expressions altered the original data curves very little.

Results

Four accelerometers were located on the flatbed to record differences and out-of-phase relationships throughout the trailer bed. After a check had been made of a few individual accelerometers by means of the computer, it was readily noted that the accelerometer in each location gave substantially the same statistical results. For the results that were considered, all accelerometer readings were combined to increase the number of occurrences over a given time interval in order to improve the statistical results.

Resultant data from the corduroy road test are plotted in the form of frequency distribution curves as shown in Figures 4 and 5. The percent occurrence scale was reversed from a standard-frequency distribution curve to read from 100 to 0. The curves then showed the percent of occurrences that are above a given g level. In Figure 4, for example, run one shows 9 percent of occurences to be above 8g's and 23 percent to be above 6g's.

Run 1 in Figure 4 shows the frequency of the vibration to be 5.4 cps or 5.4 (60) (60) cycles per hour. Cycles per hour divided by miles per hour will give cycles per mile, or

$$\frac{5.4(60)\,(60)}{6} = 3{,}240 \text{ cycles per mile}$$

The occurrences were measured in half cycles, or peaks, and 9 percent of these peaks exceeded 8 g's; therefore 3,240 (2) (.09) = 583 (8 g's) accelerations per mile.

The ultimate goal is to be able to predict the number of all accelerations per mile for all conditions. This type of data, if it is tied in with fatigue data on sensitive or other types of cargo, should furnish the basis for specifying or designing transportation routes for cargoes. A general approach of this nature on other modes, such as rail and air, should furnish a basis for mixing routes or should furnish a combination of modes to make up a route and to know the magnitude and frequency of the shock to cargo.

The tests, even for the corduroy road portion, were run for more load and speed conditions than shown here. It might be argued that any slight change in any of the variables will drastically alter the results so that an infinite number of frequency distribution curves will be required to depict the road movement of a sensitive cargo. At present, the sensitivity of the variables (road condition, tire pressure, type of tire, mass of cargo, etc.) is being studied, and it appears that not too many groupings will be necessary if the combinations are used in conjunction with a reasonable safety factor. As new developments cause large changes in the variables, the new results can be added to the existing ones and new results obtained in a matter of days. If the digital computer, semi-automatic data reduction, and standard test courses are used, a rapid test process results, which is extremely important for military considerations of shock and vibration.

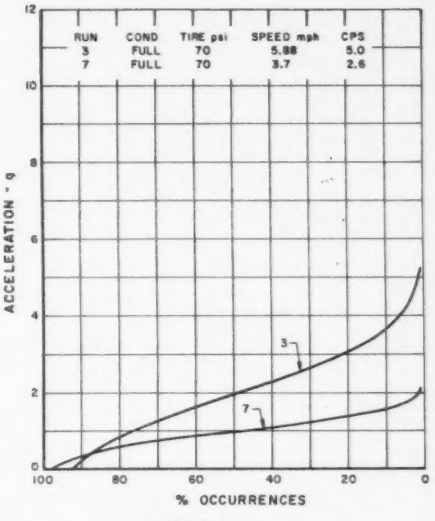


FIGURE 7

Comparison of 3.7 mph and 5.8 mph Test Runs.

The number of transportation variables is automatically reduced because the tests show certain conditions produce high accelerations; these conditions would subsequently not be recommended for transport. Figure 6 shows the frequency distribution curve for high tire pressure, high speed, and for a full and an empty load. It should be noted that 6 miles per hour is maximum for this course and that any increases over this speed is considered too risky for the driver. It is apparent that an extremely light cargo is subjected to almost double the acceleration level of that of a heavy one. This was apparent, in general, before the test was run; however, the exact number of accelerations per mile can now be determined, and this will pinpoint the importance of density to a specific cargo.

Figure 7 shows the results of the tests that were conducted when all the variables, except speed, were the same. An increase in speed from 3.7 miles per hour to 5.8 miles per hour again shows an increase in acceleration severity by a factor of almost 2. Here again speed must be weighed against military considerations and against the specifications of the cargo in order to determine the optimum requirements for transport.

Results of change in tire pressure, with the other conditions held substantially

About the Author

Mr. Robert Kennedy is the Chief, Transportation Analysis Division, Transportation Engineering Office, U. S. Army Transportation Research Command, Fort Eustis, Virginia. He was formerly with; ACF Industries as Supervisor Design Engineering, Analytic Engineer, MW Kellogg Co. and an Instructor Engineering Mechanics at the University of Maryland. Mr. Kennedy has ten years experience in development and research as regards transportation equipment for shock and vibration control. He is a registered professional engineer, a member of ASME, ASCE, and received his BS in 1949 and MS in 1952.

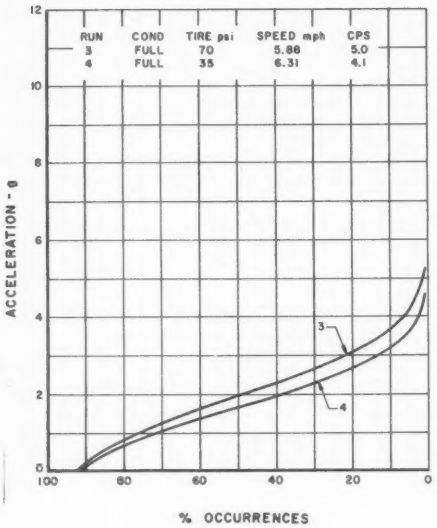


FIGURE 8

Comparison of 70 psi and 35 psi Tire Pressures.

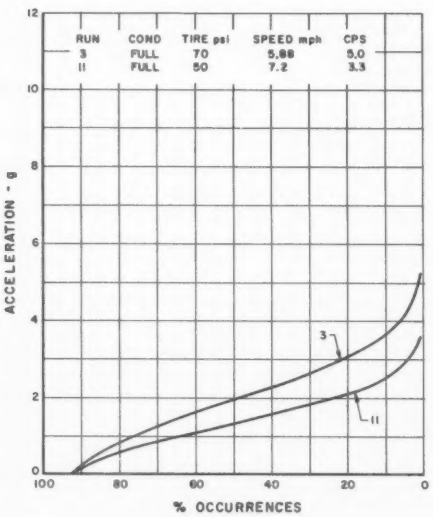


FIGURE 9

Comparison of Standard Tires and Desert Tires.

fixed, are shown in Figure 8. The change in tire pressure did not produce a change as severe as that effected by other variables. Reduction in tire pressure is usually made because of mobility considerations; moreover, some bonus is received in the reduction of accelerations.

Figure 9 shows the reduced accelerations that were attained by the use of desert tires. It must be noted that the recommended pressure for desert tires is 50 p.s.i. and that the recommended pressure for standard tires is 70 p.s.i. The reduced shocks seem to be attributed in part to differences in tire pressure. The curves show the number of accelerations for each tire at its recommended tire pressure.

It is realized that much more evaluation and analysis are necessary to determine fully the behavior of a cargo throughout a given movement. As part of this program, more test work has been performed on paved roads with the same test vehicle described herein. A visual examination of the oscillograph traces indicates that the most severe vibrations for these tests were encountered on a paved highway at a railroad crossing. It is further realized that more testing should be performed in the higher-frequency range.

The initial tests and results have been encouraging, and it is planned to continue this effort this year in additional load and road vibration studies and tests. Increased emphasis on analysis of vibrations in all planes (roll and pitch vibrations as well as vertical) will be included in the plans. Also, tests are planned for extending the number of road and off-road conditions in order to develop a broader range of road effects. Efforts will be expanded to measure more locations and more mechanical data on a vehicle. In addition, more extensive use will be made of travel transducers and strain gages for vibration measurements.

ENVIRONEWS

ABSTRACTS

THE SOLUTION OF THE EQUATIONS FOR A CASE OF STATIONARY HEAT CONVECTION IN AN INFINITE OBLIQUE CIRCULAR CYLINDER

By E. Kh. Drakhlin (U.S.S.R.)

In the problem of stationary heat convection in the centre section of a long oblique circular cylinder, contained in an infinite solid mass with a temperature gradient at infinity constant with respect to space and time, exact solutions are found for the velocity and the temperature on the assumption that the streamlines are parallel to the axis of the cylinder and that there is no temperature gradient along the axis of the cylinder.

Translation available from the Office of Technical Services, Dept of Commerce, Washington 25, D.C., #61-27298, $1.10

EDUCATION

MEASUREMENT ENGINEERING

Two short courses will be conducted at Arizona State University at Tempe, Arizona on January 29 through February 2, 1962. The theme will be "How to Obtain Valid Data on Purpose." One course will be a Lecture Program containing Basic Concepts and Special Lectures. The second course will be held in conjunction with the first and will be an Experimental Program where attendees will be able to obtain laboratory experience. A six page brochure describing the courses in detail may be obtained from:

Measurement Education Division
Stein Engineering Services Inc.
5602 East Monte Rosa
Phoenix 18, Arizona

ENVIRONMENTAL WORKSHOP

Workshops concentrating on specific aspects of environmental testing were scheduled in New Mexico as a result of the state's first proto-type conference conducted by Sandia Corporation in Albuquerque on Sept. 14 and 15, 1961.

Over 250 scientists, engineers and

This column is newly created to supply the readers with news items of general interest. Topics to be covered will be: Abstracts, Book Reviews, Education, Facilities, Member's News, New Products, Publications, and Services.

ENVIRONMENTAL WORKSHOP

Left to Right—Dr. C. Irwin Vigness meets with W. A. Gardner and R. W. Henderson during New Mexico's first environmental testing workshop.

technicians from military agencies, research and development laboratories and universities attended the initial workshop. Following the presentation of prepared papers, sessions were devoted to discussions about shock, philosophy and economics, space problems, vibration and special problems. Through this technique, specific areas of mutual interest were established to serve as subjects for additional workshops which are now being scheduled by some of the participating organizations.

R. W. Henderson, Vice President, Weapons Program, Sandia Corporation, delivered the introductory address on "The Role of Environmental Testing in Nuclear Ordnance Development."

Dr. C. Irwin Vigness, Supervisory Physicist and Head of the Shock and Vibration Branch of the Naval Research Laboratory in Washington, D. C. and member of the Institute of Environmental Sciences, was the featured speaker at a dinner meeting. He spoke on the subject of "Shock and Vibration Tests."

MEMBER'S NEWS

A. E. Creek has been appointed as engineering liaison and sales representative in the Washington-Oregon area for Wyle Laboratories' Testing Divisions and Manufacturing Division. Mr. Creek's offices are located at 10203 N.E. First Street, Bellevue, Wash.

Mr. **Jesse Markson,** president of E.R.A. Inc., Engineering Representatives, announces the completion of their new building at 330 Great Neck Road in Great Neck, N.Y. Mr. Markson also announces the addition of four engineers with wide experience and background to the field engineering staff of E.R.A. Inc. Mr. Markson is handling the Environmental Lecture Series sponsored by the New York Chapter.

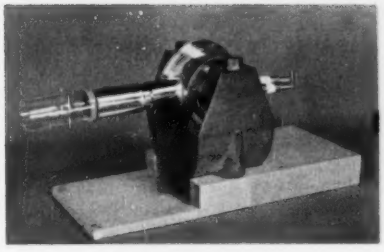
Richard F. Wenke has joined the staff of Tenney Engineering, Inc., Union, N.J., a major manufacturer of environmental and orbital simulators and electronic and ground support test equipment, as development engineer. Mr. Wenke previously was liaison engineer with International Radiant Corporation.

NEW PRODUCTS

IONIZATION GAUGE

A rugged cold cathode ionization gauge has been developed by the Geophysics Corporation of America, Bedford, Mass., which is able to withstand the extreme vibration, acceleration and thermal shock forces encountered in rocket and satellite launchings and still obtain reliable atmospheric pressure and density measurements at altitudes of more than 500 miles.

The new Magnetron-type gauge has a wide range of sensitivity (from 1 x 10^{-4} to below 1 x 10^{-11} mm of mercury pressure) and can be used for measurements in regions where the number density of particles is less than 10^5 per cubic centimeter. In addition to its



Ionization Gauge

rocket and satellite use, the gauge will also serve as a useful laboratory instrument to control or check out simulated high altitude environments or other high vacuum processing operations.

Operation and control of the unit is accomplished by an electron flow through crossed magnetic and electric fields, rather than by means of a grid-anode configuration used on conventional triode-type ionization gauges.

NEW SHAKER DESIGN

A radically new shaker design, the first major change in the relatively short history of electrodynamic shakers, has been placed in operation by Ling Electronics, a division of Ling-Temco-Vought, Inc., it was announced here today.

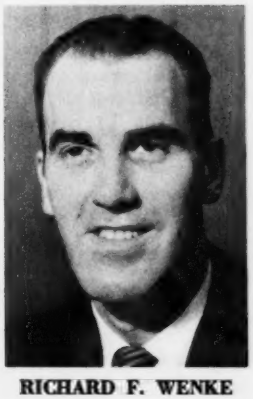
Pierce said the shaker is capable of vibrating a 100-pound package to 100 times the force of gravity and has advanced the state of vibration testing art to allow testing levels never before possible.

The new shaker, Ling Model L-200, is rated at 22,000 pounds force and is capable of taking medium size test packages to high g levels. It is driven by a 120,000-watt audio power amplifier, also manufactured by the division in Anaheim, Calif.

Continued on page 26

A. E. CREEK

JESSE MARKSON



RICHARD F. WENKE

ELECTION OF FELLOWS

JEROME BAKALISH

On October 9, 1961 the Executive Committee of the Institute of Environmental Sciences met in Detroit, Michigan. Mr. **Herbert J. Saunders,** Membership Vice President, recommended the upgrading of several members from the status of Member to that of Fellow. All recommendations were approved by the Executive Committee. The following are the new "Fellows."

JEROME BAKALISH received his education at Compton Junior college and Long Beach City College. He has been with The Martin Company in Denver for the past year and a half where he started as a Senior Engineer. He is presently a Supervisory Engineer. Prior to this he spent eight and a half years at the Firestone Missile Division in Los Angeles, Calif. where he was the Senior Engineer to the Supervisor of Environmental Test Laboratories. He began his environmental career at the Aerophysics Department of North American Aviation in Downey, Calif.

His activities in the Institute started in 1957. He served as the Treasurer and later President of the Society of Environmental Engineers. After the merger with the Institute of Environmental Engineers he became the President of the Los Angeles Chapter. He was the Registration and Fiscal Chairman of the National 1960 Technical Meeting. He has been highly instrumental in the organization of the new Colorado Chapter and is their present National Director.

JOHN R. BOYLE received his Bachelor of Science Degree from the University of Illinois in 1921. During World War I he served as a Commander of a Mine Sweeper and has since carried the nickname of "Skip." During World War II he served as a member of the government's Engineer's Inventors Commission. His work on this Commission is still classified "Secret." Since then and up until two years ago he was the President and Owner of the Boyle Engineering Laboratory which has been devoted mainly to development and research in the environmental testing field.

Mr. Boyle is the holder of more than twenty patents including the Velometer, the Dew Point Meter, and he is copyright holder of the psychrometic calculator. He has done work on corrosion caused by electrolytic action of stray current, collaborated with the Edison Company on solving some of the problems of air pollution, and worked with Mr. Clarence Birdseye in the development of some of the machinery used in the early stages of the frozen food industry.

Mr. Boyle was the first President of the Chicago Chapter. He is also a Registered Professional Engineer, Member of the Chicago Association Consulting Engineers, National Professional Engineers, Illinois Society of Engineers, American Society of Heating and Ventilating Engineers, and the American Society of Refrigeration Engineers.

JOHN J. SEXTON received his B.E.E. from Polytechnic Institute of Brooklyn. He has been with American Bosch Arma Corp., Arma Div., for the past ten years. He is presently the Head of the Technical Staff of the Development Service Dept. His duties include responsibility for long range planning of environmental facilities and their development, investigation and development of "state of the art" advances in environmental criteria, evaluation methods and instrumentation. Prior to this advancement he held the position of Head of the Environmental Section with managerial responsibility for operation of a comprehensive environmental laboratory staffed with 50 engineers and technicians. Prior to this Mr. Sexton spent three years with the U. S. Navy where his duties involved the study of environmental properties as related to antisubmarine warfare.

Mr. Sexton has been highly active in the affairs of the Institute since 1957. He has served as Facilities Chairman for the 1958 National Technical Meeting, Chairman of the New York Chapter, Member of the Executive Secretary's staff, Advertising Manager for the *Journal of Environmental Engineering,* Chairman of the New York 1959 Symposium, Chairman of the New York Professional Relations Committee, and is presently a Director for the New York Chapter.

Mr. Sexton is also a member of the New York Academy of Sciences, Instrument Society of America and the American Ordnance Association.

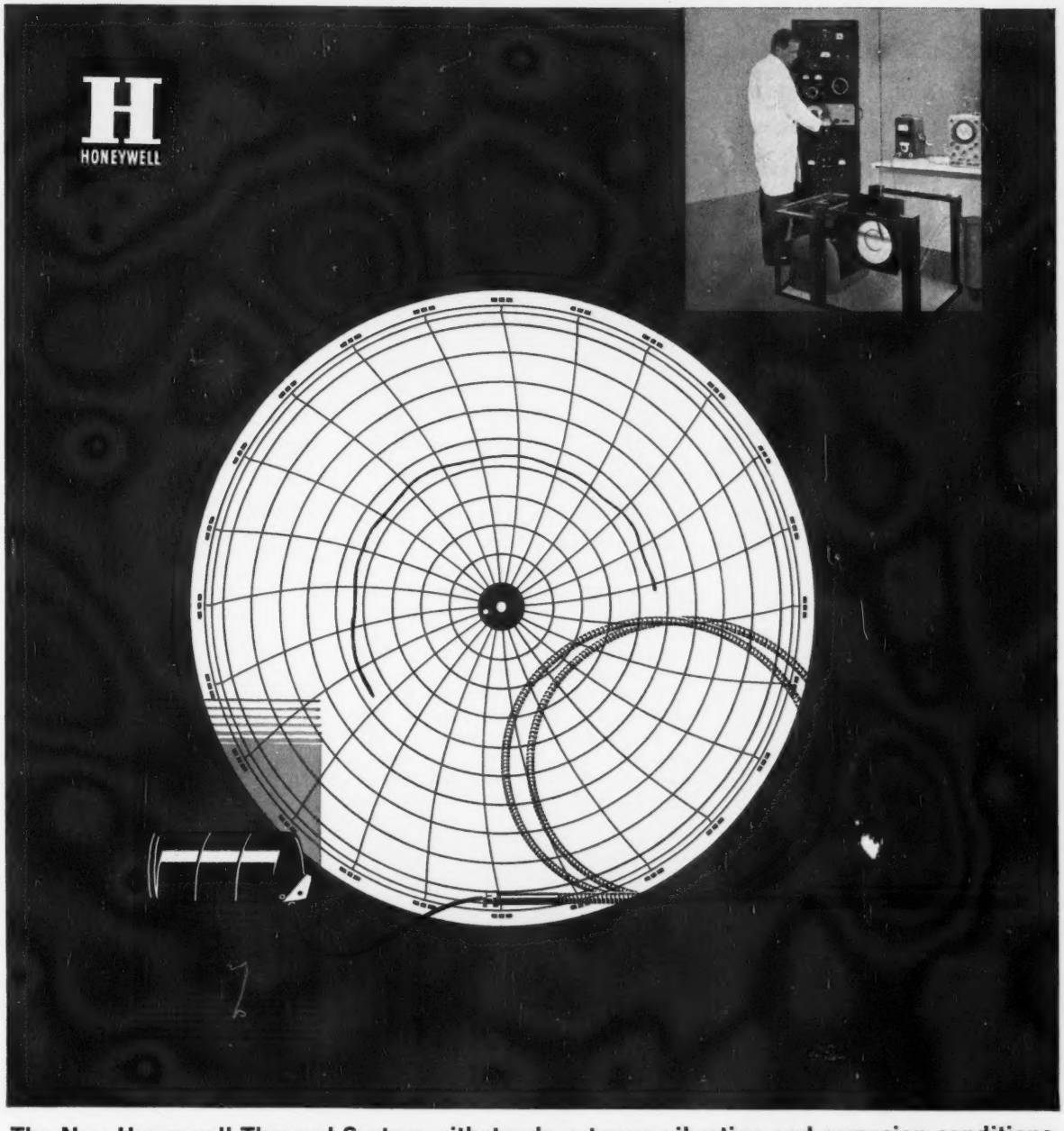
Continued

STATIC LOAD

weight or person disturbing the reflector or measuring devices during a test. The cost of the bags and blower and associated material is not high when considering the size of the article tested and it compares favorably with the cost of procuring the large amounts of weight to accomplish the same purpose. The equipment for a test as described can be stored in six boxes the size of foot lockers.

The greatest advantage is the speed of performing the tests with few personnel enabling the greatest accuracy in measurements. There is no danger of any of the measuring devices being knocked or moved, consequently the repeatability is as good as the pressure and displacement measuring devices.

Credit should be extended to personnel here at the I-T-E Circuit Breaker Company, who were responsible for the conception, design of equipment, execution and the evaluation of the tests. These people are Messrs. Burwell, Fassnacht, Kerstetter and myself.



The New Honeywell Thermal System withstands extreme vibration and corrosion conditions

Here's a new gas-actuated thermal system that takes the zig-and-zag out of temperature recording under severe vibration conditions.

A complete series of vibration tests has proved the vibration resistance of the new Class III thermal system. In these tests (shown above), the Class III system was installed in a standard Honeywell rectangular case recorder, and subjected to forced vibrations in three mutually perpendicular planes. With accelerations up to 0.2G from 0 to 200 cps, maximum pen oscillation was limited to 1.5%. For more than 75% of the range, pen oscillation was less than 0.5%, with no resonant effects at 60 cycles.

Get the complete story by contacting your nearby Honeywell field engineer. Minneapolis-Honeywell, Wayne and Windrim Aves., Phila. 44, Pa. In Canada, Honeywell Controls, Ltd., Toronto 17, Ont.

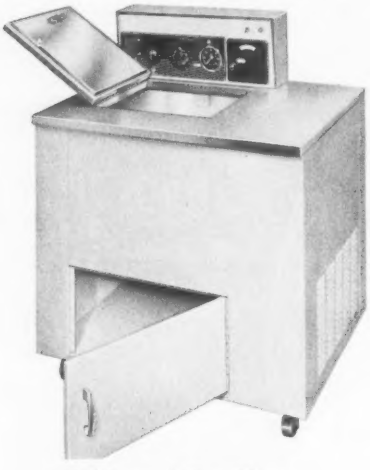
Honeywell

First in Control SINCE 1885

HONEYWELL INTERNATIONAL Sales and Service offices in principal cities of the world. Manufacturing in United States, United Kingdom, Canada, Netherlands, Germany, France, Japan.

REFRIGERATED CENTRIFUGE

An improved refrigerated centrifuge has been announced by Chicago Surgical & Electrical Co., division of Labline, Inc., Chicago. The unit, called the 20R Centrifuge, provides automatically controlled centrifugation at temperatures down to minus 20°C. Maximum speeds of 6,000 rpm. are readily secured and much higher speeds can be attained with multi-speed attachments.



Refrigerated Centrifuge

The improved model boasts of many refinements in design and performance and is suitable for all laboratory requirements. It accommodates all standard centrifuge heads for Size 1 and Size 2 units and is designed to operate with complete safety. The smooth-surfaced, inner protective shield is heavy gauge stainless steel and is easily cleaned. Temperature is controlled within ±1°C.

COLD CAPS

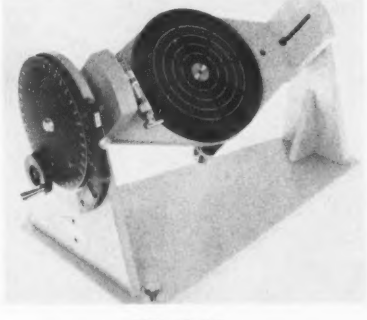
NRC Equipment Corporation of Newton, Mass., announced today that it has been granted an exclusive license by Edwards High Vacuum, Ltd. of England to manufacture and sell "cold caps" for the complete line of NRC's high speed vacuum diffusion pumps in the United States.

NRC stated that the inherently low backstreaming rates of modern diffusion pumps are reduced 98 to 99 percent by the use of the cold cap, without significantly affecting pump speed. In the specific case of NRC high speed diffusion pumps with backstreaming rates of less than 0.05 mg/cm²/min, backstreaming has been effectively reduced to 0.0005 mg/cm²/min or less, engineeers reported.

NRC is offering the cold cap as an optional fitting on all new diffusion pumps. For conventional vacuum processes, such as metallizing and some laboratory work down to the 10^{-6} torr (mm Hg) pressure range, cold caps alone are sufficient, NRC said. In ultrahigh vacuum space environmental chambers or thin film research, where cryogenic traps are used, the cold caps are effective in reducing the backstreaming rates even further, to infinitesimally small values consistent with the ultraclean requirements of these technologies.

TILT TABLES

Available in two models, the Micro Gee 201 Static Tilt Tables offer a convenient, accurate method for furnishing incremental angular inputs to accelerometers, gyros, and similar devices. Both instruments feature a large engraved vernier scale on the outer axis providing setting accuracies to 0.05 degrees throughout the 360 degree range. The seven-inch diameter platform itself can also be rotated through 360 degrees, and is indexed with a locking pin at 45 degree intervals. Initial leveling of the table is accomplished by a three-point leveling system and a spirit level aligned with the table surface.

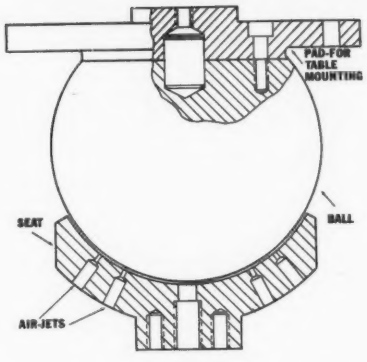


Tilt Table

For further information, contact: Micro Gee Products, Inc., 6319 West Slauson Ave., Culver City, Calif.

AIR BEARINGS

Air bearings for satellite simulators, consisting of spheres and matched seats or sockets, are now available from Industrial Tectonics, Inc., Ann Arbor, Michigan. The term "air bearings" is used because the spheres actually float on a film of air to simulate the weightless and frictionless conditions of outer space.



Air Bearing

Sphericity of bearings up to 12-in. in diameter can be held to 0.000050-in. or less with surface finish of 4 microinch or less. Other tolerances can be held consistent with requirements of matching the sphere to bearing socket.

The socket has a number of air vents so that when sufficient air pressure is supplied the sphere floats on a film of air. Nitrogen or other gases may be used instead of air. A table is mounted at the top of the floating sphere. The firm can make any practical size bearings and sockets to specifications.

For further information, write to Mr. K. W. McKenzie, Sales Manager, Ball Division, Industrial Tectonics, Inc., 3684 Jackson Road, Ann Arbor, Michigan: telephone Area 313, Number 663-2451.

TEST MACHINE POWER CONTROLLER

A new automatic power controller, designed to operate in conjunction with any standard universal testing machine, is now being marketed by The Marquardt Corporation of Van Nuys, Calif. it was announced today.

The Model TM-9 controller, an accessory of Marquardt's TM-6 universal testing machine, accurately controls high and rapid rising temperatures on test specimens within 10 degrees in a range from room temperature to 6000°F. The TM-9 utilizes the electrical resistance of the material being tested to convert the electrical energy to heat. Only the specimen itself is heated with absolute minimum thermal lag and maximum heating efficiency.

Standard ASTM specimens are heated in seconds to the required test temperature.

SHAKER CONTROLLER

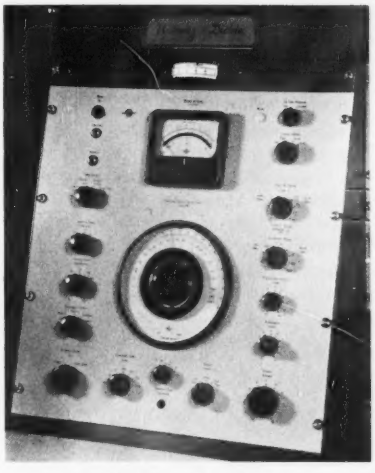
Automatic shaker control for electrodynamic Vibration Test Systems includes three functions—

a. Sweeping oscillator from 5 cps to 5 KC, and 5 KC to 10 KC. Variable speed sweep motor reverses at adjustable upper and lower limits.

b. Servo to automatically control table motion.

c. Vibration Meter transfers with servo to indicate level of displacement or acceleration controlled.

The servo and vibration meter section will control and indicate constant displacement and two levels of constant acceleration. Both levels of acceleration and the displacement level are independently adjustable. In addition, the transfer frequencies are adjustable over wide limits. Available from Unholtz-Dickie Corp., 2994 Whitney Ave., Hamden 18, Conn.

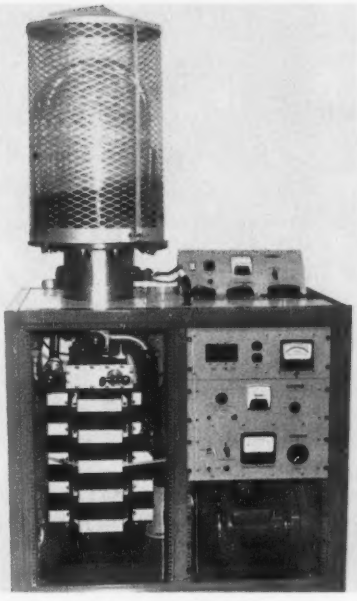


Shaker Controller

NEW VACUUM SYSTEM

Clean vacuums 5 x 10^{-9} mm Hg in 4 hours or less, without bakeout, are now readily achievable in a glass bell jar, with the "Boostivac"-equipped, ion pumped high vacuum system developed by Ultek Corp.

The complete vacuum system operates from a single electrical connection, requires no plumbing or liquid nitrogen cold traps. It is invulnerable to power failure, and provides reliable, contaminant-free vacuums without operator attention and with minimum maintenance.



Vacuum System

Complete details, both on the Boostivac and on standard systems, are available from the manufacturer: Ultek Corporation, 920 Commercial Street, Palo Alto, California.

ULTRA KRYOMATS

Lauda Ultra Kryomats are thermostatically controlled circulating refrigeration systems. They develop a high cooling capacity and can be used to dissipate large heat volumes, i.e. exothermic reactions, low temperature distillations, continuous electrophoresis, etc. The solution in the reservoir is refrigerated to an accuracy of $\pm 1°C$ (floor models) or $\pm 0.2°C$ (table models). The chilled liquid is then circulated through the control area by duplex circulating pumps which provide both pressure and suction.

For further information contact: Lauda Instruments, Inc., P.O. Box 422, Great Neck, N.Y.

VELOCITY METER

Developed for use in the package testing laboratory as a practical, low cost means of measuring dolly impact velocities of conbur incline impact testing machines, the Velometer is a compact self-contained mechanical instrument equipped with a calibrated drive unit mounted on the input shaft. The meter is supported by a weighted pedestal which is placed on the floor near the bottom of the incline track structure and so positioned that it can be actuated as the dolly passes by.

As the dolly contacts the drive unit, the meter's mechanism registers velocity in ft./sec. on its dial by means of a resettable maximum speed pointer.

Complete information may be obtained from L.A.B. Corporation, 500 Onondaga Street, Skaneateles, N.Y.

PUBLICATIONS

ANALYTICAL LAB PROBLEMS

A new 4-page folder, describing X-ray methods employed by a large analytical laboratory in handling many different tasks, is available gratis from Philips Electronic Instruments, 750 South Fulton Avenue, Mount Vernon, N.Y. Reprinted from a national research publication, the article explains analytical procedures for Meehanite, low and high-alloy and tool steels, aluminum, brass, bronze, Inconel, Monel, zirconium and titanium alloys, white-metals, die-cast, magnesium, nickel-base and cobalt-base alloys.

RMS RECORDING

Two, twenty-two page Technical Reviews "RMS Recording of Narrow Band Noise With A Level Recorder" and "Effective Averaging Time of an RMS Level Recorder." Influences in the Level Recorder that affect the measurement of the theoretically true RMS value of a statistically fluctuating signal are extensively explored. To obtain copies, request JTR-4-60 and JTR-1-61. B & K Instruments, Inc., 3044 West 106th Street, Cleveland 11, Ohio.

RUSSIAN TECHNICAL JOURNALS

1961 issues of four leading Russian technical journals, translated cover-to-cover into English, are currently being published by the Instrument Society of America under a grant in aid from the National Science Foundation. Undertaken as a service to American science and industry, the ISA "Soviet Instrumentation and Control Translation Series" is now in its fifth year. It affords U.S. scientists and engineers an excellent means of being informed about the latest developments in the field of Soviet instrumentation and automatic control.

The 1961 translations, as well as translations of previous years published

Continued on page 30

ORANGE COUNTY OFFICERS

Left to right: K. Hogan, J. Morgan, S. Frazier, Information Chairman, R. McDonald, R. Inabinette, J. Chase, Program Chairman, E. Thornton, G. Kanen, and C. Montera, Membership Membership Chairman.

LOCAL CHAPTER NEWS

Boston Chapter October meeting was held at the Raytheon Company in Burlington, Mass. The speaker was Mr. William Dunn of Tenney Engineering. His subject was "High Intensity Sound." Membership information in this area may be obtained from John A. Smith, Raytheon Company, Sudbury, Mass., Hilltop 3-9521 Ext.2131.

Chicago Chapter held their October meeting in Mishawaka, Indiana. Mr. Elmer Warnken of Cincinnati Testing and Research Labs. spoke on the "Anatomy of Manned Space Flight." Their November meeting was held back in Chicago where Mr. Andrew Marshall of Hexcel Products presented "Environmental Testing of Honeycomb Material." Membership information can be obtained from Mr. Arthur Carlson of the Ohmite Mfg. Co. in Skokie, Illinois.

Los Angeles Chapter is having an average attendance of 95 people at their Technical Meetings. Mr. Herb Waldeck of Consolidated Vacuum Corp. spoke at their October meeting. He discussed the various methods considered and the one chosen to provide a vacuum of 10^{-6} microns in the new space simulator, 47' x 25'. Their December meeting covered methods for simulating solar radiation. Their two semester course "Climatics" and "Dynamics" will start at U.C.L.A. in February. Mr. Dale Missimer of Missimer's Inc. at Glendale, Calif. is the Membership Chairman.

Michigan Chapter held their October Meeting on the evening of the National Executive Committee Meeting. Fourteen National officers attended their meeting to bring the total attendees to eighty-eight. Mr. William Gardner of Sandia Corp. spoke on "Nuclear Weapons Testing." His presentation included movies of the facilities in operation. Several of the officers met with Mr. Gardner in downtown Detroit to continue the discussion.

Mid-Atlantic Chapter had Mr. Dan Grady for their October speaker. He discussed the "Vacuum System Criteria for Space Simulation." Mr. Frank Klekotka of Heinemann Electric Co., Trenton, N. J. has taken over the duties of Chairman for this chapter due to the transfer of Mr. Pete Zukauskas to Denver, Colo.

New York Chapter held their November meeting in Manhattan where Mr. Kurt Greene of the United States Testing Company presented Electrical component Test and Evaluation Techniques. This chapter is offering free copies (while they last) of their 1959-1960 Symposium Preceedings to new members. Mr. Russell Hoffman of Hazeltine Electronics in Little Neck, N. Y. is the man to contact.

Northern California announces their nominating committee for the 1962 officers. The committee consists of J. A. Biberdorf, E. W. Hughes, D. G. Dwyre, Jr., H. Marquardt, and A. B. Millar. Their December meeting will have Mr. Fred Hermann of Tenney Engineering speaking on "Thermal, Heat Flux, and Solar Simulation in Space Simulators." Membership information for this chapter can be obtained from Mr. E. W. Carmichael of the Fairchild Semiconductor Co. in Mountain View, Calif.

San Diego Chapter has announced their program for the year through May, 1962. Information can be obtained from Mr. W. W. Russell of Wiancho Engineering Co. in El Cajon, Calif. Their December meeting will be a paper entitled "New Techniques in Random Vibration Testing." Membership information is obtainable from W. N. Hosmer of El Cajon - HO 3-2868.

Southern Ohio Chapter met at the Officers Club, Wright Patterson AFB, October 19th in the Gold Room. Fifty members attended the dinner, enjoyed a social hour prior to the dinner, meeting new and old friends. Mr. Menard of MB Electronics presented a very fine paper on random vibration pertaining to Multifilter Equalization Systems. Groups from Cleveland, Columbus, Lima and Indiana attended the dinner and the seminar. The November technical meeting was held at the Engineers Club, Dayton, Ohio. Mr. Eugene Norris of Koehler Aircraft in Dayton is the Membership Chairman.

Central New York chapter is still in the forming stage. They conducted a Technical Program in October and had Dr. Robert Mains present a paper entitled "What Constitutes Accuracy in Shock Measurements?" If you reside in any of the following areas please contact the gentlemen listed: Utica—Larry Marin of General Electric Co., Rochester—William Stewart of Consolidated Vacuum Corp., Syracuse—Murray Epstein of General Electric Co.

At their October Meeting the National Executive reviewed three applications for new local chapters. These were from Colorado, National Capital and Orange County, Calif. All applications were approved.

Colorado Chapter initially got its start through the efforts of Mr. Jerome Bakalish of the Martin Co. Mr. Bakalish is a past President of the Los Angeles Chapter. Their new officers are as follows:

President
Howard McGregor, The Martin Co.

Vice-President
Harry Williamson, Beech Aircraft Co.

Executive Secretary
Terry O'Grady, Power Sources, Inc.

Recording Secretary
Al Iadarola, The Martin Co.

Treasurer
George Zawadski, Stanley Aviation

National Director
Jerome Bakalish, The Martin Co.

National Capital Chapter draws its membership from Maryland, Virginia, and the District of Columbia. This chapter received its start through the efforts of Mr. Neal Granick of the N.A.S.A. Goddard Space Flight Center. Mr. Granick was a former officer of the Southern Ohio Chapter. Their new officers are:

President
Park Espenschade, U. S. Army

Vice-President
Harry Rich, David Taylor Model Basin

MR. PARK ESPENSCHADE
President
National Capital Chapter

Secretary
Richard Carpenter, American Machine & Foundry

Treasurer
Arthur Jenkins, Emerson Research Laboratory

National Director
Neal Granick, NASA, Goddard Space Flight Center

Orange County Chapter was formed due to the large membership in the Los Angeles area. It was felt there was room for more than one chapter here. Mr. Robert Inabinette of Pacific Scientific Company provided the original "push" on this group. Mr. Inabinette is a past President of the San Diego Chapter. Their officers are:

President
R. A. Inabinette, Pacific Scientific Co.

Vice-President
Jack Morgan

Executive Secretary
Robert McDonald, Helipot/Beckman

Recording Secretary
Gerald Kanen, Servonic Instruments

Treasurer
Kenneth Hogen, Robertshaw Fulton Aero & Instr. Div.

National Director
Ernest Thornton

Who is next? Activity is brewing in Central New York as noted above. Mr. Leonard Clark of Texas Instruments in Dallas would like to hear from persons in the **Dallas-Ft. Worth** area. Mr. Ernest Woodfill of Environ Electronic Labs. in Minneapolis, Minn. is interested in forming the **Twin Cities** Chapter. Mr. Clark Beck, Jr. of the Boeing Company is looking for other interested parties in the **Wichita,** Kansas area.

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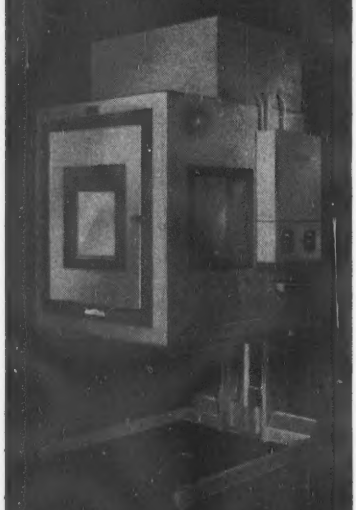

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For subscriptions or additional information write to: Foreign Translations Department, Instrument Society of America, Penn Sheraton Hotel, 530 Wm. Penn Place, Pittsburgh 19, Pa.

INFRARED TEST INSTRUMENTATION

A complete line of laboratory and production test equipment for infrared components and systems is described in a new brochure just released by Infrared Industries, Inc. The line includes comprehensive and automatic infrared detector testing consoles, radiant sources and temperature controllers, low-level amplifiers, modulator speed controls, integrators, calibrators, optical comparators and special-purpose power supplies. Many of these units have wide application in electronics outside the infrared region.

Copies of the 12-page, illustrated brochure can be obtained from Infrared Industries, Inc., Instrumentation Division, Box 989, Santa Barbara, Calif., or from Infrared Industries, Inc., Box 42, Waltham, Mass.

MEETING PROCEEDINGS

The 1961 I.E.S. Meeting Proceedings are a bound volume of 91 presentations and contain 684 pages of scientific material. These contents include multiple papers on: Philosophy of Environmental Testing, Environmental Criteria and Specifications, Simulation Methods for Normal Environments, Environmental Measurements, Ground Environment Effects, Marine Environments, Mobility, The Thermal Environment, Special Test Facility Problems. Environments of Space, Space Environments Simulation, Life Sciences and Space, Special Space Problems, Spacecraft Problems, Space Facilities, Shock and Vibration Problems, Vibration Excitation Problems, Acoustics and Dynamics.

The Proceedings are available from the National office of the Institute of Environmental Sciences, Post Office Box 191, Mt. Prospect, Illinois at a cost of $9.00 for members and $14.00 for nonmembers.

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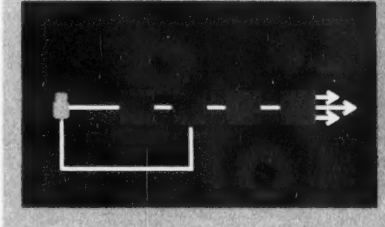
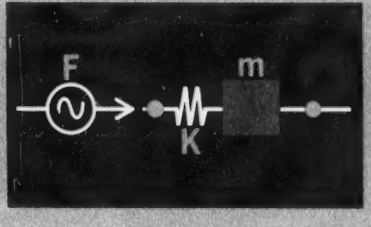
Solution: A multiple-option approach with features dependent upon the specific job. Options include: Filter, limiter, bias, super power regulator, transient suppression and calibration insertion with the unique Endevco "charge" amplifier.



MECHANICAL IMPEDANCE MEASUREMENTS

Problem: Accurate measurement of structural impedance without significantly affecting the dynamic characteristics of the structure.

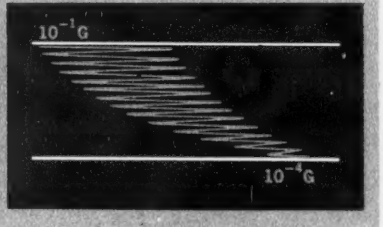
Solution: A very stiff and small combined force-accelerometer transducer incorporating the highly practical center-mounting configuration. The Endevco Model 2110 Impedance Head and Model 2953 Force Generator provide the ideal combination for accurate point measurement.

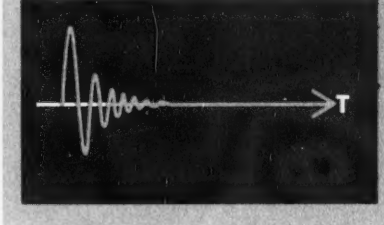


LOW G MEASUREMENTS

Problem: Broadband measurements of less than 0.0001 g with adequate signal-to-noise-ratio. The U.S. Navy "noise suppression" specification is one example [MIL-STD-740 (SHIPS)].

Solution: High output accelerometers, low noise battery operated preamplifiers, system protection against ground loop and stray field noise pickup. The Endevco 2870 and 2870M1 Systems provide these advantages.

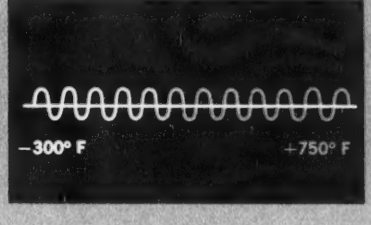




SHOCK AND IMPACT MEASUREMENTS

Problem: Ruggedness, high resonance frequency and low frequency response to measure transients whose amplitude and pulse widths cover a wide dynamic range.

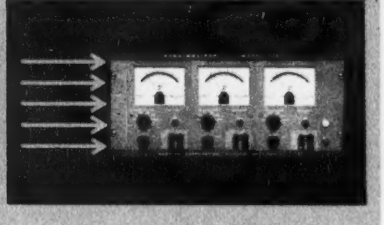
Solution: Model 2225 Accelerometer with 80 Kcps resonance frequency. Preamplifiers with flat low frequency response below 2 cps, wide dynamic range, RC time constant adjustment.



EXTREME TEMPERATURE MEASUREMENTS

Problem: Measurements at cryogenic and/or elevated temperatures.

Solution: Model 2245 Accelerometer operates at −300° F to +750° F without artificial cooling. Water cooled accelerometers operate with mounting surface temperatures of 2200° F. Other accelerometer-amplifier systems incorporate built-in compensation for extreme temperature stability throughout designated ranges.



COMPLETE LABORATORY SYSTEMS

Problem: Monitoring and/or recording dynamic outputs at semi-remote locations from piezoelectric transducers.

Solution: Endevco Model 2702B DYNAMONITOR®. One integrated system with simple calibration procedure, no capacitive signal attenuation and a built-in VTVM and galvanometer recorder amplifier.

For complete technical information about Endevco products write Department "D" or telephone SYcamore 5-0271.

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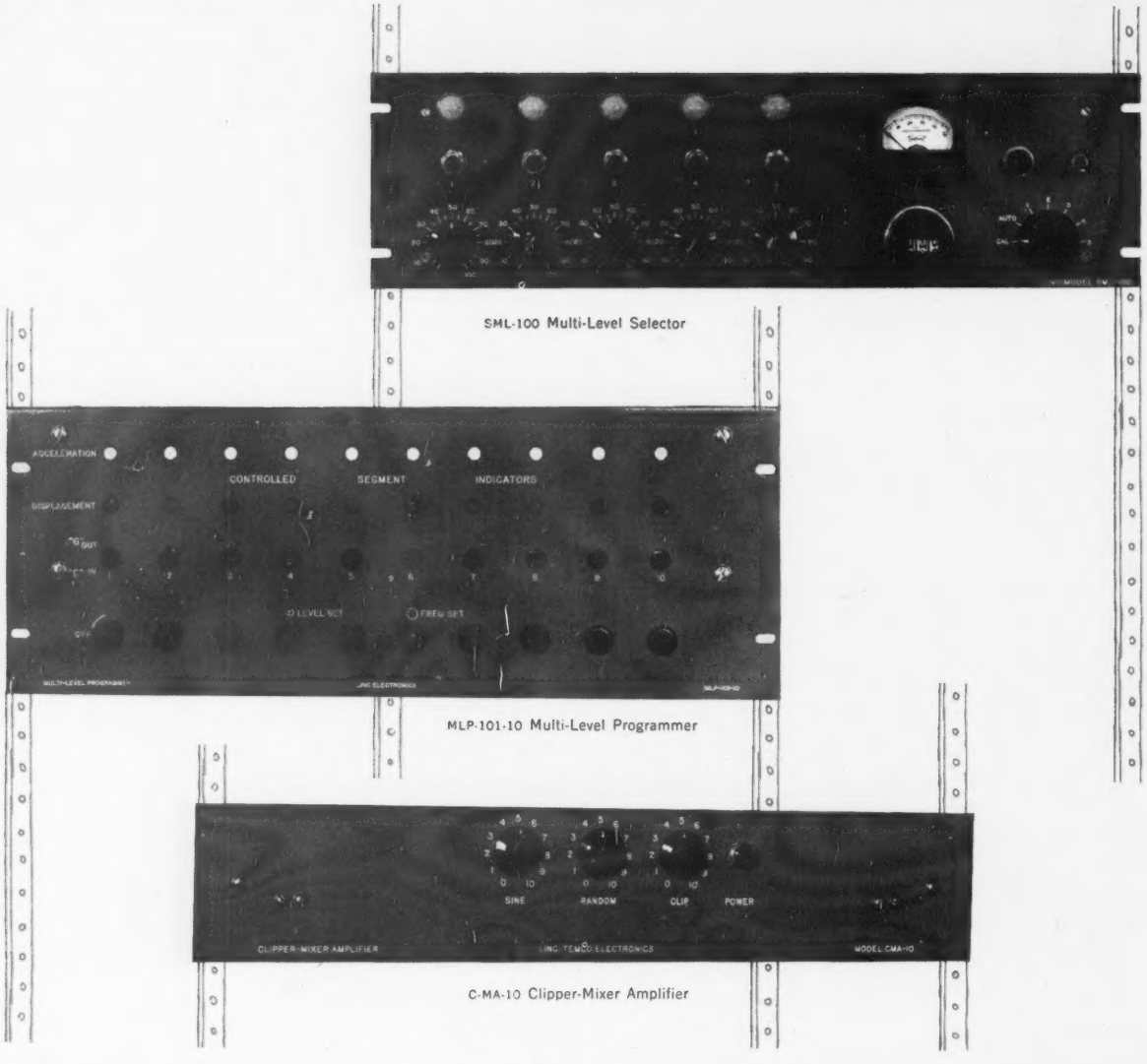

LING EXPANDS INSTRUMENTATION FOR THE VIBRATION TESTING INDUSTRY – adds three new products for control and programming

MULTI-LEVEL SELECTOR: Top, Model SML-100 allows each of five accelerometer signals, calibrated for operation at predetermined "g" levels, to limit shaker excitation to package; prevents excessive excitation of critical points in test specimen. Built-in calibrator... panel selector for automatic operation or individual channel control... light indicators identify control accelerometer... compatible with existing servo systems. **MULTI-LEVEL PROGRAMMER:** Center, Model MLP-101-10 is manually preset for change-over at desired frequencies and then automatically holds preset "D" or "g" levels over each band of frequencies. Ten transfer points are provided. The programmer is compatible with existing servo systems. **CLIPPER-MIXER AMPLIFIER:** Bottom, Model C-MA-10 is a high quality, stable yet economical unit for level control of sine or random noise signals. An internal acceleration clipper may be switched in to provide adjustable clipping of the noise signal, and sine and noise signals may be mixed for complex wave operation. For more information on Ling systems, write Department JES-1261 at the address below.

LTV

LING-TEMCO-VOUGHT, INC.

LING ELECTRONICS DIVISION

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